CIVIL ENGINEERING

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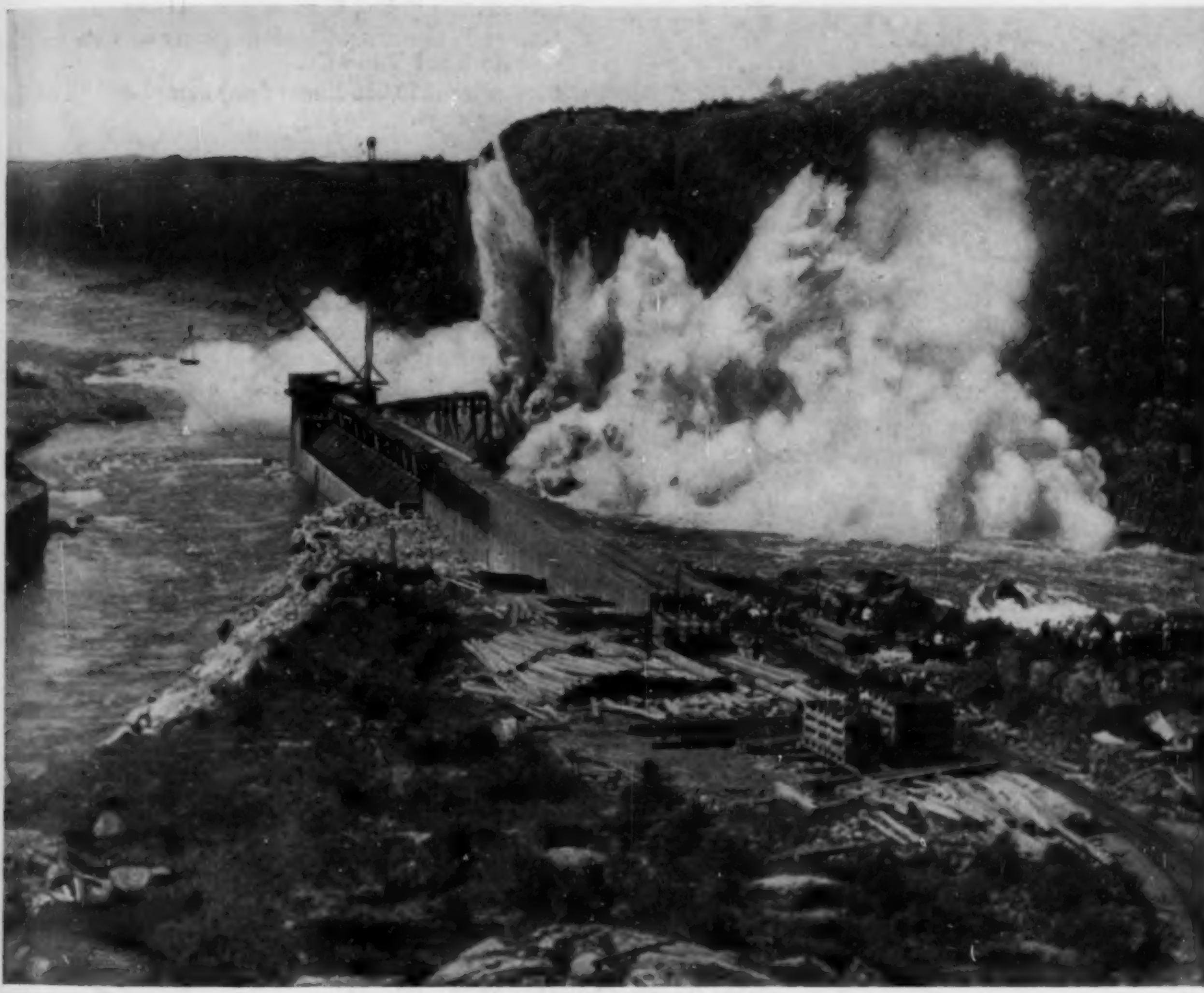

TIPPING A PRECAST DAM INTO PLACE

Volume 1 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — *Number 3*

DECEMBER 1930

Among Our Writers

Charles P. Dunn has had 20 years of varied engineering experience, his work on the Great Northern Railway and for the city of Seattle being particularly outstanding. He is at present Chief Engineer of the Alcoa Power Company, Ltd., of Arvida, Quebec.

Emory W. Lane writes on Chinese engineering from the experienced vantage point of having spent two years as Consulting Engineer for the Kiangsu Grand Canal Improvement Board and the Nantung Shore Protection Bureau. His work in the United States includes a decade of Government service.

Anders H. Bull began his engineering work in Berlin in 1896, and his European experience includes planning railways, developing radio-telegraphy, and teaching. His work in this country has been on such important enterprises as the New York City subways, the Holland Vehicular Tunnel, and the Harlem River Bridge.

Maxwell Halsey's experience as Traffic Engineer of the Massachusetts State Department of Public Works qualifies him to speak on the important subject of highway traffic problems.

Herbert F. Moore has taught for 30 years, the greater part of his experience having been as Professor of Engineering Materials at the University of Illinois. He has designed several machines for testing the strength of materials and is the author of a textbook on engineering materials.

Marshall Pitney won first prize in the 1930 contest conducted by the Colorado Section. His subject was the Alton–St. Louis Bridge, on which he worked as Inspector and Instrumentman.

William Bowie, Chief of the Division of Geodesy of the U.S. Coast and Geodetic Surveys, has during his 35 years with the Government worked in Alaska and the Philippines as well as in this country. He is President of the American Geophysical Union.

Robert S. Weston studied at Massachusetts Institute of Technology and the University of Berlin; and has had wide experience in water works and general sanitary engineering. Since 1899 he has been in private practice in Boston.

Lawrence C. Maugh's career includes two years as Bridge Designer with the Indiana State Highway Commission and eight years of teaching. Since 1925 he has been instructor in Civil Engineering at the University of Michigan.

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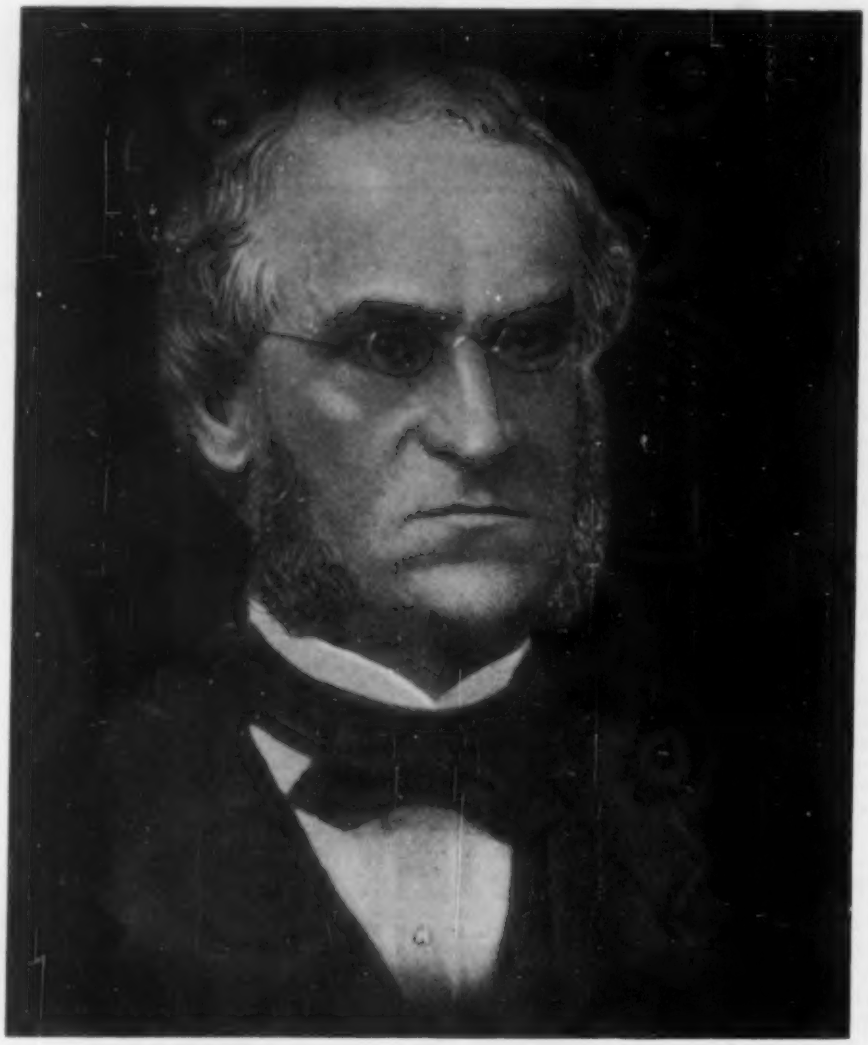

JAMES LAURIE

Born in Scotland, 1811. Died in Hartford, Conn., 1875

Built first American railroad tunnel, on Norwich and Worcester Railroad, 1836

Chief Engineer, Central Railroad of New Jersey, 1849

Chief Engineer, New Haven, Hartford and Springfield Railroad, 1862

Consultant on railway locations, dams, tunnels, bridges, and wharves

Active in organization of the American Society of Civil Engineers, November 5, 1852

President of the Society for the first fifteen years of its existence

The James Laurie Prize, for paper describing accomplished works of construction, was established in his honor, October 1, 1912

"By his talents and industry he gained the foremost rank in his profession"

J. F. Coleman
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Volume 1 | December 1930 | Number 3

Blasting a Precast Dam into Place

Monolithic Structure Erected Vertically and Toppled into Place in Swift Saguenay Current

By C. P. Dunn
Member American Society of Civil Engineers
Chief Engineer, Alcoa Power Company, Ltd., Arvida, Quebec

"NOTHING new under the sun"—yet now and again there comes to light a brand new application of time-worn engineering principles. Such was the method of diverting the swift current of the Saguenay River at Chute à Caron, here graphically portrayed. For brilliancy of conception and boldness of execution, this construction, as detailed by Mr. Dunn, takes rank with the notable pieces of engineering of recent years, if not of all time. His story will make interesting reading and arouse bold conjectures in the imagination of every engineer.

WATER may be a great boon to engineers, or it may be an even greater curse. In its wild and turbulent phases, it conveys a threat seldom equaled in construction problems. Such is the situation on the Saguenay River, in northeastern Quebec, where the Alcoa Power Company, Ltd., a subsidiary of the Aluminum Company of America, is building a 200,000-kw. hydro-electric plant at Chute à Caron. One of the most interesting yet difficult features of this project is the novel scheme, recently carried out, whereby the temporary cofferdamming and diverting of the swift stream during construction was accomplished by building a heavy concrete dam on dry land and dumping it bodily into place.

A CERTAIN RISK ASSUMED

The general plan of the project, Fig. 1, shows the arrangement of the permanent works and the diversion canal. The most economical layout dictated that the diversion canal and the powerhouse tailrace should be combined; that is, the portion of the diversion canal downstream from the dam will eventually serve as the tailrace. Upstream, the diversion canal is at a higher level, because of the 50-ft. drop where the canal passes through the dam. The closure gates in the diversion canal are located on the line of the upstream face of the dam. They are to be two in number, each 20 by 40 ft., of the Stoney type, and operated by two 100-ton blocks with 18-part tackle, provided with a double-drum electric hoist.

Surmounting the entire diversion cofferdam, including the part across the main channel, the "obelisk," Fig. 2, is a railroad trestle, which also provides support for a timber needle dam. The trestle was used in hauling stone, sand, and clay for sealing operations and will be used for operating the needles.

It was not economically feasible to construct a diversion channel large enough to take the maximum autumn flood, which may reach 180,000 sec-ft., or even the normal autumn flood of 100,000 sec-ft. The plan is that when the river discharge is less than 50,000 sec-ft., the needles will be in place and the entire flow will pass through the diversion canal, thus allowing work to proceed on the dam in the main channel. When the discharge is more than 50,000 sec-ft., however, the needles will be removed and water will flow over the cofferdam, making it necessary to discontinue work in the main channel. If the total flow reaches more than 100,000 sec-ft. for any considerable length of time, the trestle and timber frame structure will be destroyed and will have to be replaced when the flood recedes. There is a 30 per cent chance that such destruction will occur, but it was believed to be more economical to take this chance than to build much more costly structures which would surely withstand maximum autumn floods.

LARGE FLOW TO BE EXPECTED

In part, the flow of the Saguenay is regulated by the operation of the Ile Maligne hydro-electric station 23 miles upstream. It is necessary for Ile Maligne to discharge 15,000 sec-ft. on Sundays and 35,000 sec-ft. on week days. Maximum floods, which cannot be controlled at this station, may reach 400,000 sec-ft. in June, due to melting snow, and 180,000 sec-ft. at any time in the summer or fall, due to rains.

In addition, the necessity for diverting a flow amounting to 35,000 sec-ft. during the low-water season, in a stream with steep slope and high velocity, made the cofferdamming and diversion problem one of unusual magnitude.

UNIQUE COFFERDAMMING FOR MAIN CHANNEL

After the diverson canal entrance had been cofferdammed and excavated by ordinary methods, and the cut-off cofferdam removed, the diversion cofferdam, a rock-filled crib, was carried as far out into the stream as was possible by ordinary construction methods. The last step of the diversion, the closure of the main

channel, was accomplished on July 23, 1930, by a novel method.

In brief, this method consisted of building a precast concrete dam, standing on end, at the side of the main

OBELISK FOUNDATION, RAILROAD-RAIL FACING ON ROLLWAY
U-Shaped Reinforcing Run Through Rail Webs and Welded in Place

channel, and tipping it over at the proper time into the main channel. This scheme for placing a precast monolithic dam accurately in position had not been used before. Essentially, it involved the following features: (1) a fixed pier, relatively massive, to carry the greater part of the weight and thrust; (2) a small pier carrying part of the weight, to be blasted away; (3) a cylindrical rolling face on the fixed pier, so designed and placed, at such a location and elevation, that the precast dam would fall into an accurately predetermined position. These features are illustrated in some detail in Fig. 2.

The term "obelisk" was early applied to the precast dam because, before the dimensions were known, it was mentally pictured as a slender shaft. As constructed, it was rather plump and bore little resemblance to an Egyptian obelisk. But the name stuck, just the same.

Fortunately, a convenient location for the final closure was available, a point where the main channel was about 110 ft. wide, and 23 ft. deep at extreme low water, with a water velocity of about 20 ft. per sec. On the west side of the main channel was a projection of bedrock which formed an island at extreme low water. The ordinary crib cofferdam structure could be carried across the shallow part of the river to this island, but no further. It was therefore chosen as the proper spot on which to build the obelisk.

A CONCRETE WATER PLUG

Accurate determination of the topography of the river bed in the main channel was, therefore, a necessity. It was accomplished by taking soundings with a 1,000-lb. cast-iron ball, suspended from a cableway, and operated by a hoisting engine, the cableway being shifted up- and downstream so that the desired area could be thoroughly covered. As these measurements fixed the dimensions of the obelisk, the success of the closure is in large measure due to the skill and care of the riggers and survey crew in making these soundings.

As built, the obelisk was 92 ft. high, 45 ft. thick up and downstream, and had a maximum depth of 40 ft. (Fig. 2). It contained 5,400 cu. yd. of concrete, weighing 10,900 tons. The face toward the channel was contoured to fit the bottom of the river, and the fit accomplished was remarkably close. In its final prone position, the obelisk checked the calculated location within 1 in. in lateral measurements up and downstream and transversely across the river. Its top surface, 45 by 92 ft., was within about 1 ft. of the planned elevation, being about 2 ft. out of level across a diagonal from highest to lowest point. Although it fell in swiftly moving water 28 ft. deep, the obelisk was not carried downstream at all, as far as could be observed; in fact, the top surface was not even wet.

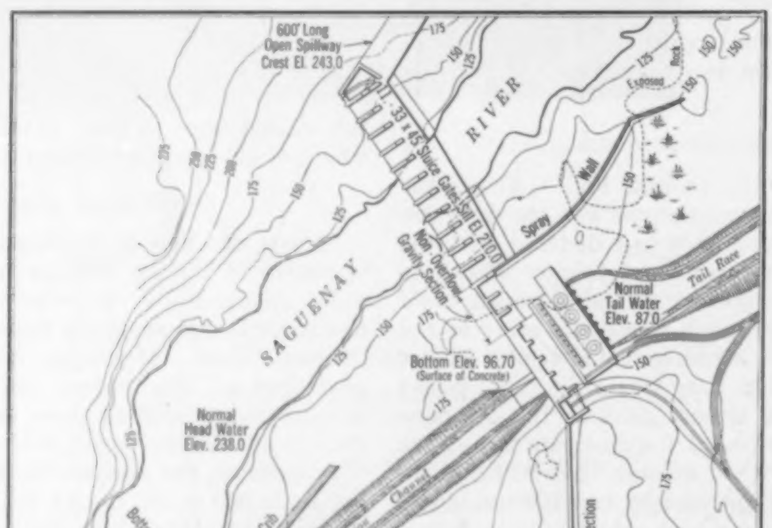


FIG. 1. CONTOUR MAP OF DAM SITE

PREDICTING AND ACCOMPLISHING THE FALL

Because of lack of precedent and scarcity of knowledge of what would happen when 11,000 tons of concrete dropped into swiftly moving water 28 ft. deep, unusual

caution was observed in the design. Spaces 8 ft. wide were left at each end of the calculated prone position of the obelisk, these to be closed later by stop logs, pushed and rolled down the face of the obelisk and the adjoining piers, working from the top downward. After the obelisk was in final position, it was found that the spaces at its ends could have been made narrower; but even so they were not difficult to fill.

In order to get the correct combination of shape of pier, location of pier, elevation of top of pier, radius of cylindrical rollway, and contour of face of obelisk, it was necessary to calculate the path of the falling body. This was a matter of fairly simple mechanics, there being few uncertainties. The uncertain items, which could not affect the result to any appreciable degree, were as follows:

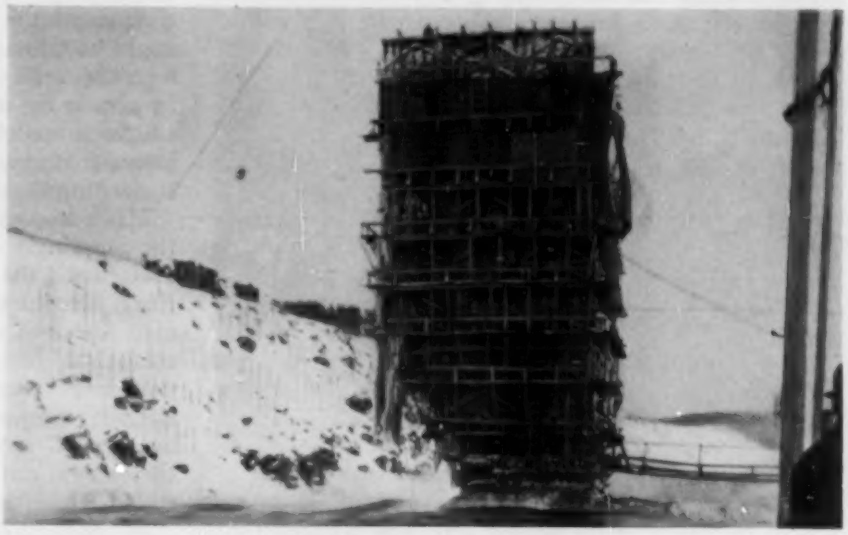
1. Air resistance. This factor was neglected.

2. Coefficient of friction between the cylindrical rollway and the base of the obelisk during the fraction of a second just prior to the cessation of contact. This coefficient was estimated. An error would have had no very great effect on the final result.

3. Effect of water cushion. This was calculated roughly by assuming that the obelisk momentarily displaced $1^1/_2$ times its own volume of water. The displaced water being accelerated and removed in a known fraction of a second, it was possible to calculate the retarding force applied to the obelisk.

Model experiments indicated that this crude assumption was reasonably close to the truth. In the model, and in the prototype also, the impact was measured by recording the motion of weighted springs carrying a stylus, which left a record of its movement on smoked glass.

Proportions of the main supporting pier, the rollway, and the obelisk were fixed so that the base, or the end nearest the supporting pier, would strike the river bottom a fraction of a second before the outer end; that is, the obelisk had not rotated a full 90 deg. before it touched bottom. The plans were made in this way because it was believed that there would be less probability of the mass being shattered if the lower end touched first. As it later developed, this precaution, combined with the other preparations, was ample to ensure the safe dropping of the huge mass.



WINTER CONSTRUCTION ON OBELISK
Note Forms, Housing for Heating, and Ice Formed by Condensed Steam

FALLING TIME DETERMINED

In all, the time of falling, from the firing of the blast until the mass came to rest on the river bed, was about $5^3/_4$ sec. In studying several tentative arrangements of detail for the supporting pier, it was found that, while the total time of fall would be materially changed by a change in starting moment, this would have a relatively small effect on the path of the falling body.

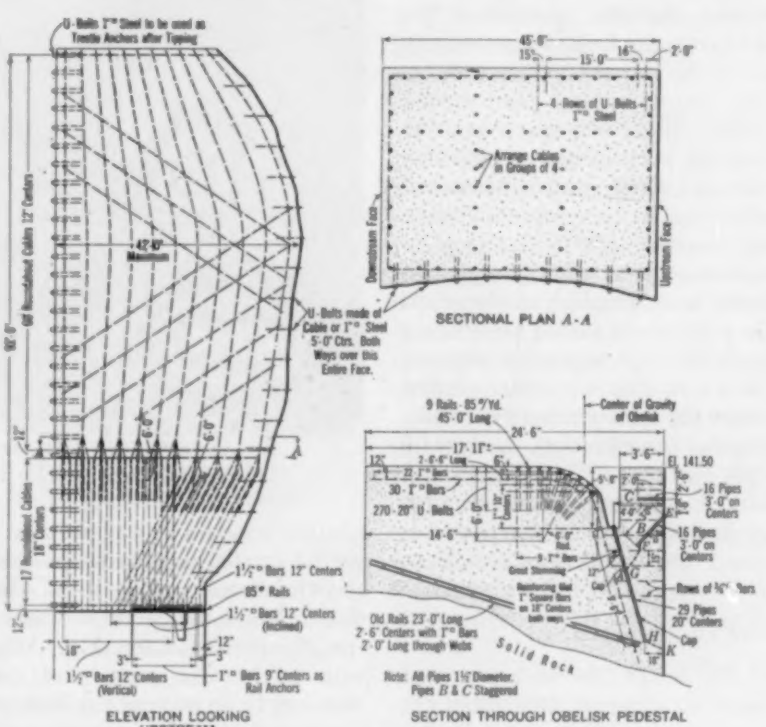


FIG. 2. SECTIONS THROUGH OBELISK

In order to minimize the bond between the obelisk and its main supporting pier, it was at first proposed to use building paper; but it was feared that the dumping from 4-yd. buckets of concrete containing large aggregate would break the paper, hence it was decided to use bituminous paint. A strip of the main pier surface 2 ft. wide, immediately back of the tangent point of the rollway, was left unpainted because it was desired to concentrate the loading on this pier at as near the tangent point as possible.

A concentration of the main pier reaction near the tangent

point, as compared to a uniform distribution of the reaction over the entire pier, would result in a greater portion of the total weight being carried by the main pier. This was a desirable condition as the small supporting pier was loaded heavily in any case and it was desired to minimize its burden. It was believed that, to some extent, the main pier reaction could be concentrated near the tangent point by omitting the heavy paint just there, because, as the building of the structure progressed and the load increased, the paint would to a certain extent compress easily without taking much load, leaving the unpainted strip to carry the greater part of it.

TRESTLE ON COFFERDAM
Slight Discharge over Cofferdam and Through Trestle

It was computed that the obelisk would cease contact with the cylindrical pier face after having rotated 49 deg. from the vertical. Marks on the rollway face after the obelisk was tipped indicated that this is approximately what occurred, but it could not be checked exactly.

In view of the tremendous pressures certain to occur, the rollway face of the pier and that portion of the obelisk base which rolled over the pier were heavily reinforced and shod with 85-lb. railway rails on 10-in. centers, as shown in the accompanying photograph. The weight on the cylindrical rollway was approximately 500,000 lb. per lin. ft.; and the pressure per square inch was probably from 12,000 to 20,000 lb. on the combined steel and concrete surface. The concrete between rails on the rollway surface was only slightly damaged.

Throughout the calculation on which the design was based, cut-and-try methods and graphic arithmetical integrations were used, the path of the falling body being traced step by step. One of the typical graphs prepared in these calculations is shown in Fig. 3. Other similar diagrams were used to picture the relations between time, angular displacement, angular acceleration, horizontal and vertical velocities of the center of gravity, horizontal and vertical acceleration of the center of gravity, tangential force necessary to maintain angular acceleration, centrifugal force, and angular velocity. These graphs were developed by arithmetical integration.

STUDIES FOR REINFORCING

During the progress of the design, the idea persisted that the huge mass of concrete, falling on the rock of the river bottom, would be considerably shattered. It was considered necessary to heavily reinforce the entire mass, so that the whole would be held together after this occurred. For reinforcement, old steel cables were largely used. They were preferred to reinforcing steel because of their greater flexibility. In addition to the longitudinal cables grouped in fours, diagonal strands were placed throughout the mass so that no matter what direction might be taken by a line of fracture, it would be crossed by cables nearly perpendicular to it, which would hold the fragments in place. For example, in the upper two-thirds of the obelisk, enough diagonals were inserted to insure that at least 60 per cent of them would cross any horizontal plane.

Much to everyone's surprise—and probably because of the amazingly accurate fit of the obelisk to the river bottom and the effectiveness of the water as a cushion—there was no shattering into fragments. The precast dam remained a monolith after falling, with only a few small hair-like cracks produced. This might indicate that more reinforcing steel than necessary was used; but, if performing a similar operation again, I would hesitate to reduce the amount because another time there might not be such an accurate fit of the dam to the river bottom, and greater impact would result.

In connection with this particular problem, some interesting data were developed by building models of very weak concrete, having strength in correct proportion to that in the prototype. For example, the obelisk itself was built of 2,400-lb. concrete, whereas some of the models tested had a strength of only 60 lb. per sq. in.

A WINTER JOB

Conditions required that the obelisk structure be built during November and December 1929. Cold weather concreting was necessary because the pier could not be started until extreme low water, late in the fall, and the structure had to be completed during the low-water period, while there was convenient access to the equipment for concreting. The concrete was placed with a derrick, using 4-yd. buckets. Lifts of 10 ft. were used except near the bottom where the forms overhung, and it was impractical to hold them for depths greater than 5 ft.

CONSTRUCTING OBELISK FOUNDATION
Cofferdam Enables Pouring During High Water

Temperatures during a large part of the concreting period were from 20 to 30 deg. below zero. The surface of the concrete was kept from freezing by housing in with light timber frames, canvas, and building paper about 2 ft. away from the forms, and by discharging live steam into the space between. The accumulation of ice from the condensed steam is shown in one of the photographs. The concrete, however, was not frozen.

It is greatly to the credit of the construction organization that this difficult and dangerous work in cold weather was accomplished without any accidents. The 28-day strength of the concrete in the various parts of the structure was as follows:

Main supporting pier	3,500
Small pier, which was blasted	3,800
Lower 10 ft. of obelisk	2,900
Remainder of obelisk	2,400

OBELISK TOPPLES AT SECOND ATTEMPT

On account of the enormous weight involved, the only practical way of tipping the obelisk was to build it on two piers, one to be removed by blasting. The main pier, farthest away from the channel, Fig. 2, was by far the more massive of the two and carried about two-thirds of the weight. The center of gravity of the obelisk overhung the tangent point of the cylindrical rollway by 3 ft. 5 in., this giving a starting moment of about 75,000,000 ft-lb. The small pier, which was blasted away, was 3 ft. 6 in. thick, and carried about one-third of the total weight.

Blasting holes, arranged as shown in Fig. 2, were provided when the pier was built, it being planned that the

THE OBELISK TIPS INTO PLACE
Water Splashes 150 Ft., Smoke Obscures Flying Forms

lower holes would be fired first, splitting off the pier, and that the small holes would be fired by delay exploders about 1 sec. later, demolishing the structure so that large fragments would not prevent the obelisk from settling into place properly. The holes were formed by imbedding pipes in the concrete. The first charge used totaled 180 lb. in 61 holes, amounting to $2^1/_4$ lb. per yd. of material to be removed.

Referring to Fig. 2, the loadings used in each hole were:

Holes A. Eleven cartridges of 40 per cent gelatin, $1^1/_4$ by 8 in. were detonated by two electric blasting caps, one cap in the fourth and one in the ninth cartridge from the bottom. Dry grout was used for stemming.

Holes B. Two cartridges, 40 per cent gelatin, $1^1/_4$

OBELISK JUST BEFORE TIPPING
Note Profile to Fit Contour of River Bottom

by 8 in., were primed with one first delay electric blasting cap, and the holes filled with grout to the collar.

Holes C. One cartridge, 40 per cent gelatin, $1^1/_4$ by 8 in., was primed with one first delay electric blasting cap.

This first charge was insufficient to remove the pier, and the obelisk failed to tip. The pier broke along the line *E F G H K*, as shown in Fig. 2. At the second try, about 3 hr. after the first, the small pier was successfully removed by placing 1,000 lb. of 60 per cent powder in the recess between the two piers. This effectively destroyed the remaining part of the small pier without damaging other parts of the structure. In one way it was unfortunate that so much powder was used, because the smoke obscured the falling obelisk so that the moving picture record of the fall, taken for scientific purposes, was incomplete.

CUSHIONING THE IMPACT

During the progress of the design, there had been considerable discussion of various schemes for cushioning the fall so that the mass of concrete would not be shattered too greatly. It was early suggested that the face be completely padded with something in the nature of baled hay, or a layer 4 ft. thick of spruce poles lashed in place. A study carried out with the aid of a model indicated that the best, and in fact the only, practical cushion would be an ample depth of water.

One of the most useful results of the model tests was in checking the calculations of the performance of the water cushion. The proper depth in which to tip the obelisk having been determined, this depth—28 ft.—was obtained by adjusting the gates at Ile Maligne a few hours before the obelisk was tipped. The cushion was thoroughly effective and did not cause any objectionable motion downstream or elsewhere.

FREE FALL OF ONLY FOUR INCHES

In fact, the impact, as measured by recorders attached to the obelisk, was almost imperceptible—no more than that which would be caused by a free fall of only 4 in. The falling mass of 11,000 tons settled so

gently into place that, apparently, it would have been perfectly safe for a person to ride on the obelisk during the entire period of its fall. No one asked for that privilege, however.

To a considerable extent, the effectiveness of the water cushion depended on the accuracy with which the obelisk fitted the contour of the rock stream bed, because the greater part of the retarding effect was caused by water being accelerated and removed at extremely high velocity during the last few feet of motion. It is probable that water was moving out from under the obelisk at velocities as high as 600 ft. per sec. just as the mass approached its final position.

OBELISK IN POSITION
Gaps at Ends Partly Closed. Note Target at Center of Gravity

An interesting feature of the placing of the obelisk was the complete destruction of the forms left on the face toward the channel. The timbers were split and broken into small fragments by the water moving at high velocity out from under the obelisk. Some of the timber fragments were thrown a distance of 300 ft. The photograph shows the movement of the displaced water.

MOTION PICTURES OF TIPPING OBELISK

Several moving picture cameras were used because it was desired to obtain a record of the spectacular features of the event as well as to record the scientific phases. One of the cameras was slow motion with 128 exposures per second. The others were standard cameras. A seconds pendulum was placed in the field of view of one of the standard cameras in order to time the fall accurately, and a painted target, shown in the photograph, was placed on the downstream face of the obelisk, to mark the center of gravity.

COMPLETING THE COFFERDAM SEAL

The final sealing was quickly and economically accomplished. The procedure was, first, the closure of the gaps at the ends of the obelisk with 12 by 12 in. timber stop logs; second, the filling of the spaces with rock-filled cribs decked with concrete; and third, the sealing of the obelisk along the bottom by placing coarse rock, fine rock, sand, and clay, using 20-yd. side-dump cars. Shortly after, the trestle was extended and the needle dam erected. One of the photographs shows this stage of the work.

A complete mathematical analysis, covering all phases of the problem, was independently made by Donald J. Bleifuss, Assoc. M. Am. Soc. C.E., Assistant Engineer, Aluminum Company of America, and by N. C. Riggs, Head of the Department of Mechanics, Carnegie Institute of Technology, both of Pittsburgh. These mathematical studies were checked by model experiments made by A. J. Ackerman, Jun. Am. Soc. C.E., Assistant Engineer, Aluminum Company of America, Pittsburgh. The results obtained from each of these several independent studies agreed very closely with one another.

Of especial value were the model experiments, which served to confirm our belief in the usefulness of hydraulic models. This case in particular was interesting because it so clearly demonstrated that it is practical to correctly establish the similitude of mechanics, hydraulics, and strength of materials. The results of the model tests were correctly interpreted, and the performance of the prototype accurately forecasted.

The idea of building a temporary diversion dam by the novel methods described in this article, was conceived by James W. Rickey, M. Am. Soc. C.E., Chief Hydraulic Engineer of the Aluminum Company of America, Pittsburgh, and was carried out under his direction. The dam was designed by me in the offices of the Alcoa Power Company, Ltd., at Arvida, Quebec.

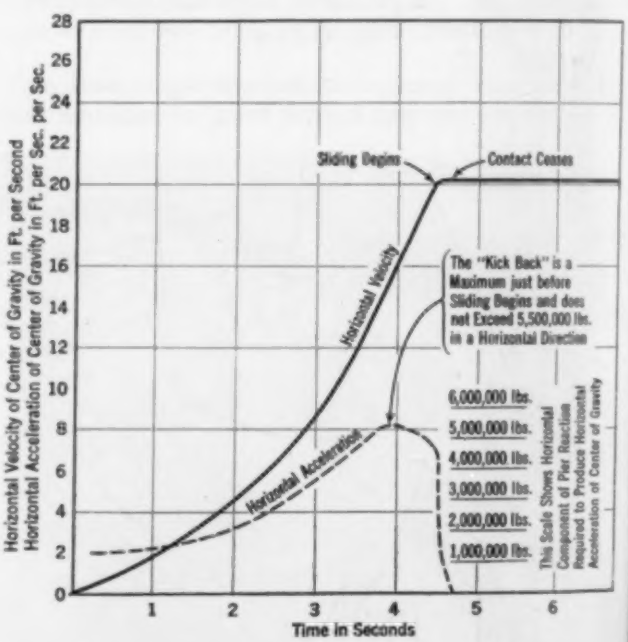


FIG. 3. DETERMINATIONS FOR FALLING TIME

ALL TOLD, A MOST SATISFACTORY METHOD

From every angle, the results obtained with this hitherto untried method of closing and completing a difficult cofferdam have been very satisfactory. All the engineers connected with the project have full confidence in the workability of the scheme and will use it again when occasion demands.

Controlling Floods in China

Century-Old Fight Against the Rampages of the Yellow River

By E. W. Lane

Member American Society of Civil Engineers

Research Engineer, U.S. Bureau of Reclamation, Denver, Colo.

The personal experiences of the author in working with the Chinese reveal interesting details of oriental methods of design and construction used centuries before our adoption of them.

This is the second article by Mr. Lane on Chinese engineering methods to appear in Civil Engineering.

The locks along the Grand Canal, which have been briefly described in the October number, merit fuller consideration. Probably the most noteworthy are the four pair just below the old Yellow River bed, which can best be described as flight locks of three lifts having very long chambers. The flight consists of four sluices with stop-log gates (with a duplicate sluice in reserve at each place) between which are long chambers formed by sections of the canal, one chamber being three miles long. At the present time, the structures are not operated as locks but simply as sluices through which the boats are dragged with cables wound around windlasses and operated by dozens of men. One of these locks with the capstans in the foreground is shown in an accompanying photograph.

In the days when great fleets carried rice to the Emperor's court at Peking, a large number of boats were allowed to pass through the lowest sluice; the stop-logs were placed in the grooves; and the flow of water down the canal filled the pool to a level sufficient to float the boats easily through the next sluice and into the pool above. Stop-logs were then placed in the second sluice, and the operation was repeated. In flood times the water rushes through these sluices with such velocity that navigation is suspended.

Fine Engineering Feats

One cannot help being greatly impressed by the excellent masonry work of the Chinese engineers, of which these locks are an example. The facing of all their structures is ashlar masonry of blocks so accurately cut and laid that one can hardly insert a knife blade in the cracks. All of the masonry is laid in lime mortar, as the Chinese have never developed a hydraulic cement, and this probably accounts for the very close joints. The backing of the walls may be stone laid in lime mortar or native concrete. All of the masonry structures in this section of the canal seem to be built on piles, although in some cases the clay foundation would be sufficiently strong without them. I have never seen any evidence of settlement in any of their structures. The piles are small and driven very close together by means of a cylindrical stone weighing about 200 lb., used as a rammer. It is fitted with handles around the circumference and raised and dropped by six men who form a circle around the pile. When long piles are used, the men stand on a platform attached to the pile; and as the pile goes down, the platform and driving crew go down with it.

The culverts and sluices for discharging irrigation water from the Grand Canal were mentioned in the foregoing article. They are interesting structures, and some of them are of considerable magnitude. I had occasion to examine thoroughly the construction of a large sluice at the head of the canal branching off from the Grand Canal. This sluice was suffering from one of the prevalent evils of China, the lack of provision for maintenance work on structures. The floor paving was gradually being washed away, and part of one of the walls had fallen down 11 years before, but nothing had been done in the way of repair.

I prepared a plan for repairs which I estimated would require an expenditure of $20,000 in gold, but the plan was not carried out, and the next year a large flood entirely destroyed the sluice, and necessitated its reconstruction at a cost of $55,000 in gold. The walls of the original structure were formed of coursed ashlar masonry laid in mortar and founded on wooden piles, and the floor consisted of one course of cut stone over a

Canal Sluice Lock with Capstans Used in Hauling Boats

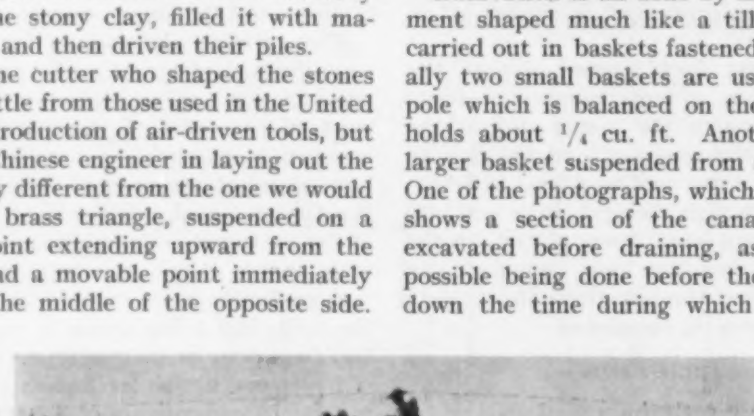
Flow Through a Sluice Lock During a High Flood

layer of Chinese concrete resting on piles. The piles under the walls were driven very closely together at the face of the wall, probably to form a sort of sheet piling, although the Chinese engineers may have realized that

REPAIRING DAMAGE TO THE NAN GWAN FLOOD-RELIEF SPILLWAY

this portion of the wall exerted the greatest pressure. The subsoil of the region is a hard, stony clay, but in removing some of the piles after the structure was destroyed, it was discovered that the material surrounding them was an entirely different kind of clay, free from stones. The constructors of the sluice had evidently excavated a hole in the stony clay, filled it with material free from stones, and then driven their piles.

The tools of the stone cutter who shaped the stones of this masonry differ little from those used in the United States prior to the introduction of air-driven tools, but the level used by the Chinese engineer in laying out the structure is considerably different from the one we would use. It consists of a brass triangle, suspended on a string, with a fixed point extending upward from the angle at the bottom and a movable point immediately above it attached to the middle of the opposite side. When the movable point hangs exactly over that at the bottom, the device is level. Observations made with a modern engineer's level on the flood spillways previously described indicate that the levels used were subject to errors of a few inches in a hundred feet. It is improbable that the ancient Chinese engineers had levels sufficiently accurate to lay out long canals; for this purpose they probably had to depend on the level of the water itself.



DRIVING A LONG PILE

EARTH EXCAVATION METHODS

Some portions of the Grand Canal are silted so badly that navigation is nearly impossible at low water. Other sections are more or less regularly cleaned out. The work is done in the winter, when traffic on the canal is light, and when the local inhabitants, who are mostly farmers, are idle and can be secured in large numbers to work on the canal. A temporary dam is thrown across at both ends of the section to be cleaned,

OLD SWANG KING SLUICE AT HEAD OF SALT CANAL

and the water in the canal between the dams is drained through the irrigation sluices into the lower land to the east. Thousands are then employed to excavate the canal, and in about a month a section five miles long can be cleaned out.

Excavation is all done by hand, with a native implement shaped much like a tilling spade. The earth is carried out in baskets fastened to carrying poles. Usually two small baskets are used, one on each end of a pole which is balanced on the shoulder. Each basket holds about $^1/_4$ cu. ft. Another form of carrier is a larger basket suspended from a pole between two men. One of the photographs, which was taken at low water, shows a section of the canal in which silt is being excavated before draining, as much of the work as possible being done before the closure in order to cut down the time during which it is necessary to keep the canal closed. The work is divided into small sections, and each section is assigned to a gang. Men, women, and children are all employed at the work, and payment is usually on a yardage basis.

Because of the vast number of people available for the work, it can be done by hand as quickly as with a large excavating plant and much more cheaply. I was identified with one project in which earth was excavated from a canal and carried about 200 ft. at a cost of $2^1/_2$ cents in gold per cubic yard. With what type of modern excavating machinery could this have been done as cheaply? The Chinese have not developed any method of excavating hard earth covered with more than a foot or two of water, and in this

field there is a market for modern excavating machinery. They have, however, a method of excavating mud from canal bottoms to be used as fertilizer for their fields. For this purpose they use a tool very similar to our

FOUNDATION OF A MASONRY IRRIGATION SLUICE

post-hole digger, but it is not rugged enough for use in anything but soft mud.

THE HUAI RIVER FLOODS

It was my privilege to be connected for three years in an advisory capacity with the Kiangsu Grand Canal Board, which had charge of the canal from the Yangtze River northward to a point somewhat above the entrance of the Yi River. The board was charged with the duty of modernizing the canal, but in reality its function was much broader in that it also involved responsibilities for flood control. The problem of the Grand Canal in this region is so intimately connected with the flood problem of the Huai River that the two cannot be separated. The Huai River floods are the result of past floods of the Yellow River, and the Yellow River problem has previously been so thoroughly described by Dr. John R. Freeman in "Flood Problems" (TRANSACTIONS, Vol. 81, 1917) that it will be only briefly stated here. The Yellow River is remarkable in that it not infrequently carries as much as 10 per cent of silt in its water. It rises in a high land covered with loess and debouches into a low, flat plain, the gradient across the plain being insufficient to produce a transporting velocity, so that some of the sediment is dropped in the river bed, gradually filling it up. As the river bed rises, the Chinese build up the levees until the bed has risen above the level of the surrounding land. Eventually there occurs a break in the levee which cannot be closed, and the river then takes a new course to the sea, forming a new channel which it fills up in the same way, thus repeating the cycle. These cycles may be several centuries in length.

A CHINESE LEVEL

Prior to 1194, the Huai River was a normal stream, and its floods did not cause unusual damage. In that

THE GREAT DIKE

year, however, the Yellow River broke through its southern levee and flowed out over the plain. The breach in the levee was not closed, and the river found for itself a new channel which intersected the Huai River about 50 miles above its mouth. It immediately began to deposit silt in the bed of the Huai River, making it more and more difficult for the Huai floods to reach the sea. Finally, the Huai outlet was so obstructed that its water started to take a southerly course over the low land to the Yangtze River. In order to force the Huai water down its usual course, a great levee was constructed, during the Ming dynasty, from the high land to the west to the junction of the Huai and Yellow rivers.

THE GREAT DIKE

This dike, an immense structure about 35 miles long, 30 ft. high, and 100 ft. wide on the top, is faced for its entire length with an ashlar masonry wall. For many years it successfully prevented the Huai floods from entering the land to the south, but as the bed of the combined Huai and Yellow Rivers was filled higher and higher with Yellow River silt, it became insufficient, and several emergency sluiceways were built in it to prevent its being overtopped. These permitted the excess water to flow into the triangle of land south of the Great Dike between the high land to the west and the Grand Canal. This water then gradually drained out, through the Grand Canal and other small streams, to the Yangtze River. With the continued rising of the river bed, the openings of the emergency spillways in the Great Dike became so frequent that eventually no attempt was

made to close them, and the Huai River cut a new channel for itself to the southward until now practically all of its discharge reaches the Yangtze.

In 1851 another breach occurred in the north bank of the Yellow River, and it again changed its course.

THE OLD BED OF THE YELLOW RIVER

It entirely abandoned what had formerly been the Huai River bed and left, not a deep river channel leading to the sea, but two ridges across the country, generally from one to five miles apart, and filled with fine silt to a level high above that of the surrounding country. The accompanying photograph shows one side of this ridge, the right side being the natural level of the country and the left the former river bed.

THE TEN DAMS

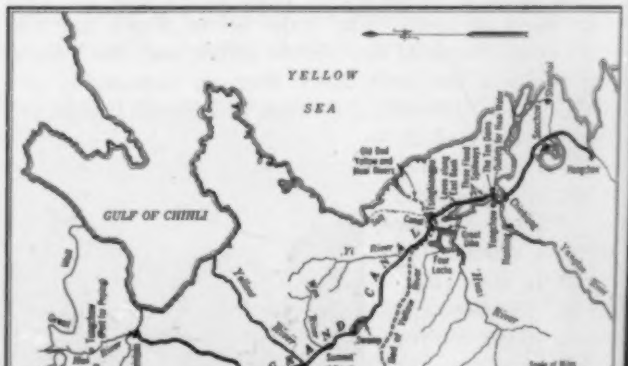
When the relief spillways in the Great Dike started to discharge water into the flat plain to the south, the Chinese built a second line of defense by raising the east bank of the Grand Canal, thus protecting the rich lands between the canal and the sea. They also opened up new channels to carry this water to the Yangtze River. These channels cross the Grand Canal about 20 miles above the Yangtze, keeping to the low land while the canal turns through a cut in the higher land to reach the city of Yangchow. They offer a more efficient outlet to the Yangtze than the canal, and if they were not closed during the dry season the entire available water supply of the canal would escape through them and the canal would dry up. To prevent this, the openings are kept closed by a series of dikes, known as the Ten Dams, until high water comes, and then a sufficient length of these dikes is removed to permit the water to pass out. Only six of these dams, which have a combined length of more than half a mile, are used at the present time. During high water the channels closed by them discharge about 170,000 sec-ft.

In order to keep a sufficient depth of water in the Grand Canal, these openings must be closed against a head of water. The method used is ingenious. To begin the dike, a boat is anchored a short distance out from the bank, then a series of ropes, at the same level and about a foot apart, are stretched between the boat and the bank. A layer of reeds is laid over these ropes, forming a sort of suspension bridge. On the reeds is deposited a layer of earth and then another layer of reeds. Alternate layers of reeds and earth are added until a considerable thickness of material is built up. The ropes are then slacked off, which allows the material to settle down and other layers to be added. This process is continued until the bottom layer of reeds rests on the bottom of the river. The ends of the ropes attached to the boats are then loosened, looped over the

THE LEVEE ON THE EAST SIDE OF THE GRAND CANAL DURING A FLOOD

top of the mass to form a dike, and then tied to stakes on the bank. After this the boat is moved farther out into the stream, and a new section of dike is constructed, between the boat and the end of the previous section. Fortunately, the bottom of these outlet channels is usually clay and does not erode very deeply during the closure. This method, varying somewhat in form, is extensively used for closing levee breaks in China.

As a means of regulating flow the use of dikes may seem crude and uneconomical, and in the United States it undoubtedly would be, but the situation in China is different. Labor there is very cheap, and interest rates



MAP SHOWING HUAI AND YELLOW RIVERS

are very high. The average annual expenditure on the temporary dams is about $10,000 in gold. In the United States this would justify a capital expenditure of about $160,000; but in China, on account of the high interest rate, the expenditure would not be over half that amount, and would be entirely insufficient to build a permanent structure for the purpose.

FLOOD-RELIEF SPILLWAYS

As the Huai became more and more filled with silt and caused the discharges through the Great Dike to be more

frequent and of greater magnitude, the outlets to the Yangtze eventually proved to be insufficient, and breaches in the protection levees on the east bank of the Grand Canal occurred. Since the land into which the water flowed was lower than the bottom of the canal, it was very difficult to close the breaks and, in order to reduce flooding, "fuse-plug" spillways were put in. There are three of these in service at present, with a combined discharge capacity of about 200,000 sec-ft., and two more which are in such shape that they cannot be used. These spillways consist of wide sloping masonry floors with retaining walls at each end and an earth embankment forming a continuation of the levee resting on the spillway floor between the end walls. When the floods reach such a height that the safety of the east bank levee is seriously threatened, a small cut is made in the earth bank of one of the spillways and the remainder of the earth is washed out by the force of the water. If the flood continues to rise, the second and, if necessary, the third spillway is opened.

One of the Ten Dams

Flood Discharging Through the Nan Gwan Flood-Relief Spillway

Two of the spillways still in service were built in 1702 and the third in 1767. Thus we find that the fuse-plug idea, so recently adopted for the Mississippi River flood-control works, has been used in China for 200 years. Strictly speaking, however, Chinese spillways are more like the "controlled spillway"—to use the term current in the Mississippi River controversy—than the fuse plug, since they are artificially opened by making a small hole in the embankment and have a masonry weir which limits the discharge. They differ, however, from the controlled spillway being built at Bonnet Carré in that they cannot be closed until the water has fallen considerably. The method used to close them is the same as that previously described for closing the Ten Dams.

During my service on the Grand Canal, a large flood—probably the largest in a century—occurred, and it was necessary to open all three of the spillways. Figure 1 shows a plan and cross-section of one of these structures, while the flow of the water through the Nan Gwan spillway at the peak of the flood may be seen in one of the photographs. The floor consists of one or more layers of cut stone in lime mortar laid on a layer of Chinese concrete. In some cases, where the service is not so severe, only Chinese concrete was used. This seemed fairly satisfactory, but as it was built in layers, there was a tendency for the water to peel them off.

Nan Gwan Flood-Relief Spillway

CHINESE CONCRETE

Chinese concrete is extensively used in the construction of locks and sluices. It is not nearly as hard or strong as ours, but is a useful material where weight is required and a little strength is sufficient. It probably has very slight hydraulic properties, for, although I have never seen it used where it would be constantly submerged, it is often employed for the floors of sluices where it will be wet for long periods. It is possible that its hydraulic properties result from the same causes as do those of mortar made from slaked lime and pulverized, burned clay. In India, dams with a volume as great as 400,000 cu. yd. are built with this burned, clay-lime mortar. A specification for Chinese concrete follows.

Proportions

The lime mortar should be composed of lime and dried, pulverized clay, mixed, and moistened with water in which gelatinous rice has been boiled. The earth suitable for the lime concrete should be dried and sifted.

The rice water can be made by thoroughly boiling 360 cu. in. of gelatinous rice in water sufficient to dampen 1 cu. yd. of concrete. For fuel, 800 lb. of wood are required, and the rice water should be thoroughly stirred and evenly mixed.

The contractor, at the direction of the engineer, may be required to use either of the following methods of mixing the lime concrete:

First Mixing Method

The lime should be unslaked, broken into small pieces, and sifted through a sieve of about $^1/_4$-in. mesh. Six parts of earth and one of broken, sifted lime should be thoroughly mixed together until an even color is obtained.

The mixture should then be moistened with enough rice water to make it tamp readily into a solid mass.

Second Mixing Method

The lime should first be slaked by placing it in a pit in a layer 6 to 8 in. deep and adding $2^1/_2$ to 3 times as much water. The pits should be covered with mats until the lime is thoroughly slaked. The lime should then be allowed to cool.

The lime paste should be thoroughly mixed with the earth in the proportion of 1 part of lime to $2^1/_2$ parts of earth, and sufficient rice water should be added to make the mixture tamp readily into a solid mass.

Placing

The mixture of lime and earth should be deposited in layers, not over 7 in. thick, and thoroughly rammed by approved rammers, operated by four men, which pass back and forth over the concrete until no water is brought to the surface. This means that the rammers must pass over each point at least 12 times.

PORTLAND CEMENT INTRODUCED

The Chinese did not use sheet piles in these sluices—probably because of the cost of large timbers. Instead they drove three lines of piles, 5 to 7 in. in diameter, as close together as possible. These piles are large from the Chinese standpoint. Such piles would not be very effective in cutting off underflow but they were quite serviceable in the clay soil on which the spillways are founded, in preventing undercutting.

The spillways were severely injured by the flood, and I prepared plans for repairing them with modern methods and materials. But opposition to the use of concrete made with portland cement developed and only two of the spillways were constructed according to plans. There was good reason for the opposition, because in repairs made after the preceding flood a material represented as concrete made with portland cement had been used and, in spite of much greater cost, proved unsatisfactory. Judging from the remnants of this material, the "cement" seems to have been a mixture of not over 1 part portland cement with 5 parts of slaked lime. As soon as we began to put in concrete made with real portland cement, those who were repairing the other spillway with native cement saw the superiority of the modern material and adopted it for their work.

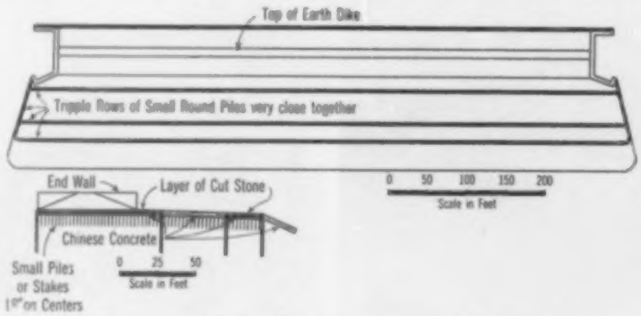


FIG. 1. PLAN AND CROSS-SECTION OF THE CHA LOO FLOOD-RELIEF SPILLWAY ON THE GRAND CANAL

There is a current impression that the Chinese are slow to adopt new ideas, but I do not believe this to be the case. The situation in the regions where there has been little contact with foreigners is much the same as it would be if a man from Mars should appear and tell us of the wonderful building materials used on that planet. Where structures of great importance were concerned, we would want convincing proof before we would be willing to adopt the visitor's recommendations in place of materials and methods we had long found successful.

EXCAVATING SILT FROM THE GRAND CANAL

Quest of Elasticity

Advantages and Shortcomings of Present-Day Test Methods on Engineering Materials

By H. F. Moore

Research Professor of Engineering Materials, University of Illinois

SINCE the "good old days," so well remembered by older engineering graduates, in which they toiled with test specimens and machines in the "lab," great advances in methods and technic have taken place. Reviewing these from the vantage point of a long contact and an analytical mind, Professor Moore here recounts, in his characteristic manner, his experience and conclusions on the elasticity of materials. This paper originally appeared as part of the Civil Engineering Session of the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education at Yale University, on July 11, 1930.

TO SOME it may come as a shock to hear that students of the engineering mechanics of materials are necessarily idealists, yet I wish to make just this statement. The whole theory of elasticity—of which ordinary engineering mechanics of materials is an abbreviated and simplified edition—with its elaborate mathematical processes, and its experimentally determined constants, rests on the assumption that the materials studied are homogeneous, isotropic, and indefinitely divisible without change of physical properties. As materials actually fall far short of meeting these assumptions, this science has a distinctly idealistic basis.

In spite of the apparently hopeless discrepancy between these fundamental assumptions and observed physical structure, the mathematical theory of strength of materials usually works satisfactorily when used by structural engineers and machine designers. The fundamental assumptions are "statistically" true for actual materials, that is, they are true for volumes of material containing a fairly large number of the unit crystals, fibers, or pieces of aggregate of which the whole is composed. Moreover, in all observed cases, when the theory is in error, it errs on the side of safety.

PHENOMENA OF INELASTIC ACTION

One of the limiting conditions for the satisfactory performance of materials in service is that there shall be no appreciable inelastic action. The question as to how much inelastic action may be deemed "appreciable" is capable of a wide variety of answers under different circumstances. Three evidences of inelastic action may be mentioned: (1) permanent set upon removal of load; (2) loss of energy during a cycle of loading or unloading, such as the gradual dying out of the vibrations of a spring; and (3) a departure from Hooke's law of proportionality of stress to strain.

Logically, there seems to be no connection between these three types of evidence. A material with a stress-strain diagram like that in Fig. 1 (*a*) would have no permanent set; yet it would show a departure from Hooke's law and loss of energy (mechanical hysteresis). A material with a stress-strain diagram like that in Fig. 1 (*b*) would show a permanent set and hysteresis, but not a departure from Hooke's law. Practically, most materials used in structures and machines have stress-strain diagrams of the type shown in Fig. 1 (*c*), although certain organic materials, notably rubber, are exceptions to this statement. The stress-strain diagram for release of load is very nearly parallel to the low-load portion of the stress-strain diagram for the application of load.

If this parallelism were exact, the evidence for inelastic action by set, by hysteresis, and by departure from Hooke's law, would appear at the same stress, and q in Fig. 1 (*c*) would be a precise measure of the permanent set after the application of the stress *FO*. As a matter of fact, the parallelism of *OA* and *CD* is approximate rather than exact, but limits for elastic action determined by direct measurement of set, by development of mechanical hysteresis, and by the location of the "break" of the stress-strain diagram from a straight line, do not differ very widely for most materials.

MICROSCOPE SHOWS ACTION IN INDIVIDUAL CRYSTALS

Inelastic action in materials has become better understood since the metallurgical microscope has come into common use. As increasing load is applied to a metal, at some fairly well-defined critical load lines appear, extending across the surface of the crystalline grains, as seen in the photograph. These lines seem to be the edges of thin laminae within a grain, which become visible as the laminae slide over each other, something like the action cartooned in Fig. 2. This slipping action seems to be a shearing rather than a pulling apart in tension; evidently, if it is carried far enough, considerable pulling apart of material must result.

Using the X-ray spectrograph as a tool, the modern physical chemist has come to the conclusion that whatever the nature of atoms in a solid, their arrangement in the crystal of a material is along the lines of a regular geometrical pattern. Several such patterns have been mapped out for various metals, from which it is evident that along certain planes within the crystal, atomic attraction is at a minimum and sliding is most likely to occur. This theory has been most beautifully verified by Gough, of the British National Physical Laboratory, who, in tests of single crystals of metal, has identified the slip planes, as shown by the microscope, with the planes of most probable slip as determined from the geometrical atom pattern (the space lattice).

In Gough's experiments, the elastic strength of single crystals was very much lower than that of multi-grained pieces of the same metals; and in single-crystal specimens slip took place, not along lines of maximum stress, but along lines of maximum atomic weakness. For ordinary multi-grained pieces of metals, then, it seems that the elastic strength lies mainly in the interference to slip

offered by a multitude of grains with heterogeneous orientation of atomic patterns.

From the modern viewpoint on the structure of solids, in connection with the obvious non-homogeneity of metals, wood, concrete, and clay products, it must be recognized that for any actual material the existence of a true elastic limit is a myth.

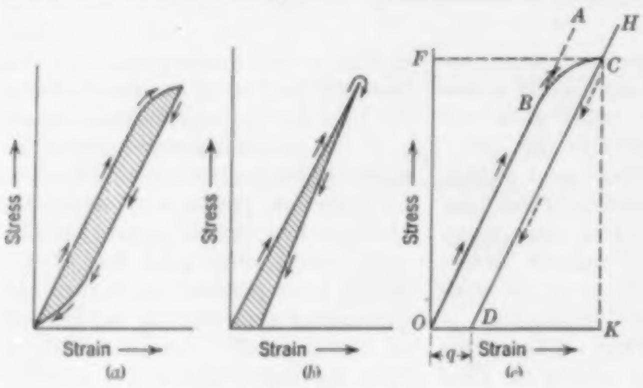


FIG. 1. STRESS-STRAIN DIAGRAM

PRACTICAL DETERMINATION OF ELASTIC STRENGTH

If we must abandon the hope of finding for any material an absolute elastic limit, we are by no means prevented from finding a limiting stress which will be a practical measure of elastic strength. Rather unfortunately, three terms have come into use which define three ways of determining elastic strength. The use of these terms, "elastic limit," "proportional limit," and "yield point," has tended to obscure the fact that what engineers need is a term to designate practical elastic strength. For example, testing engineers are arguing whether it would be better to select one of these terms, probably yield point, and re-define it to make it simply a general expression for elastic strength, or to try to introduce a new term, such as "elastic strength" or "yield strength."

In any practical determination of elastic strength, the value obtained is an arbitrary one corresponding to some tolerance of inelastic action. It is true that a common laboratory method of determining a proportional limit consists of taking a series of readings of load and of stretch and then plotting a load-stretch diagram. The stress at which this diagram "departs from a straight line" is then reported as the proportional limit, and is sometimes called a "true" elastic limit. A moment's reflection will show, however, that this method involves tolerances, vague in amount.

The sensitivity of the testing machine and of the strain meter, the scale for plotting the diagram, the judgment used in drawing it through the plotted points, the selection of a curved ruler to join the straight line part of the diagram with the curved part—all these involve uncertainties, indefinite in amount and, in the case of diagrams without a sharp "break," Fig. 3(a) for example, the location of this point of departure is uncertain over a considerable range of stress. In my opinion, this is a very unsatisfactory method. A more useful index of elastic strength is the determination of a stress at which there is, for any material, a definite amount of departure from elastic conditions.

ORDINARY METHODS LONG IN USE

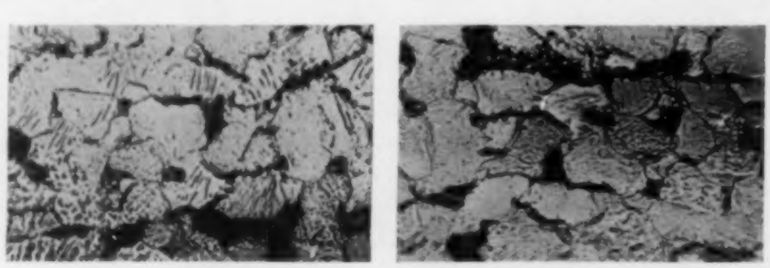
The simplest method of locating an index of elastic strength is by the "drop-of-beam" of the testing machine. This should be used only for materials whose stress-strain diagram shows a flat portion after inelastic action becomes appreciable; Fig. 3(b) shows such a stress-strain diagram. When, in a test, the stress reaches the value OA, the rate of strain suddenly changes and, in consequence, the operator of a beam balance testing machine overruns the load very slightly and the beam "drops." If a self-indicating testing machine is used, of the Emery-Tatnall or Amsler type, the pointer of the weighing scale halts.

This method is not at all applicable to materials having a stress-strain diagram like that shown in Fig. 3(a) and its chief drawback for any material is the ease with which an erroneous value for "yield point," as the elastic strength determined by this method is usually called, may be obtained by an unskillful operator, or by one who is unscrupulous.

A second method of determining elastic strength for materials of the type illustrated by Fig. 3(b) is the total strain method. For such a material, if the strain be measured for any point between A and B, the corresponding stress will be about the same, and will be closely related to the stress at the first large inelastic action. An arbitrary amount of strain, ON, is chosen, corresponding to some point which it is known will lie on the flat portion of the diagram, and when the strain reaches this value, as measured by a micrometer, or sometimes by the direct application of dividers, the corresponding stress is reported as the elastic strength. Evidently this method can be used only in the case of materials for which the general characteristics of the stress-strain diagram are thoroughly known; it is not applicable to the determination of elastic strength of new materials.

The advantage of these two methods lies in the fact that their use enables a value of elastic strength to be reported without drawing a stress-strain diagram. Their limitation is that they are only available for materials having a stress-strain diagram of the type shown in Fig. 3(b). This practically limits their use to the softer steels and a few soft, non-ferrous metals.

A slight refinement of the drop-of-the-beam method consists in using a micrometer strain meter and, as load is applied to the specimen, noting the load at which the rate of strain suddenly increases, the point of "jump" of the extensometer. This method may be used for some



MICROPHOTOGRAPH OF STRUCTURAL STEEL
The Metal in Its Original Condition, Left, and After Being Stressed Beyond Its Elastic Strength, Right

metals which do not show a well marked drop-of-the-beam, but it is only a slight improvement over the simpler method.

JOHNSON'S METHOD

For general use with materials, and for careful determination of elastic strength for any material, a method involving the drawing of a stress-strain diagram gives more precise results than the simple ones already outlined. One such method is that recommended and used by the late Prof. J. B. Johnson, in which an arbitrary increase in the rate of strain with respect to stress over its initial value is the determining factor.

This rather involved definition is clarified by Fig. 4, in which OPA is the stress-strain diagram for a material. The initial rate of increase of stress with respect to strain is given by the ratio $Mm \div OM$. Then mn is drawn of such a length that the ratio $mn \div Mm$ shall be the desired increase in rate of stress; Johnson recommended that this ratio be taken as 0.50. Next On is drawn, and parallel to it $O'n'$, tangent to the stress-strain diagram. The point of tangency, P, determined by eye, locates the limiting stress, whose magnitude is represented by PR or OQ. I have found this method very satisfactory, especially in view of the fact that it involves essentially a rate of increase; hence the value determined is theoretically independent of the scale used in plotting the diagram. Practically, this value is only slightly affected by considerable changes in the scale of the diagram.

ARBITRARY ASSUMPTION OF PERMANENT SET

The elastic strength is, or should be, a measure below which damage to a material due to inelastic action is negligible. The evident indication of such damage is a permanent set remaining after the load is removed, and the most satisfying way to determine a limiting stress is to make a series of loadings on a specimen, each load being slightly higher than the preceding, and releasing the load after each reading, to determine directly the stress at which some arbitrary amount of permanent set appears.

This process, however, would be extremely tedious, and a fair approximation of the same result may be reached by assuming that the stress-strain diagram for decreasing load has the same slope as does the initial part of the stress-strain diagram for increasing load. By this method, a stress-strain diagram is drawn, as Fig. 1 (c). Then a certain arbitrary amount of set is chosen as the index of appreciable inelastic action, as represented by q; and DH is drawn parallel to OA. The limiting stress is then located by C, the point where DH cuts the stress-strain diagram. The distance, CK, or OF, gives the value for elastic strength. This method is now receiving favorable consideration among testing engineers. The arbitrary value for q must be chosen with respect to the material considered and the service required for a machine or structural part.

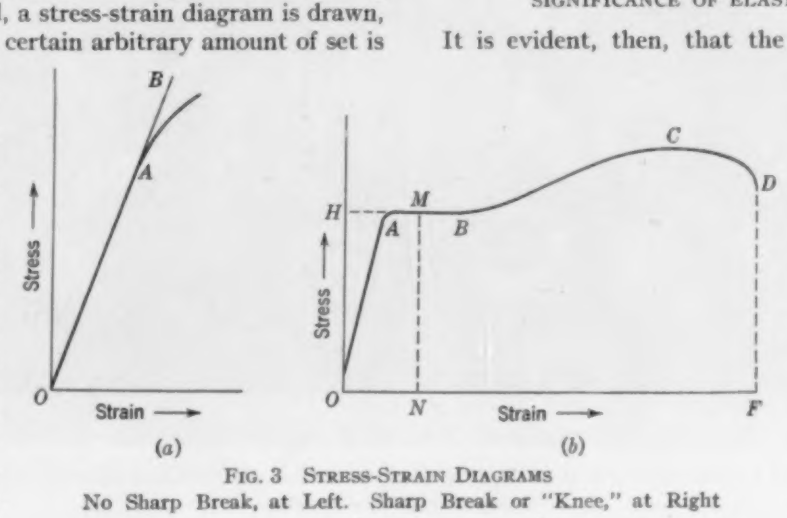


Fig. 3 Stress-Strain Diagrams
No Sharp Break, at Left. Sharp Break or "Knee," at Right

A QUICK DETERMINATION

Most practical testing engineers object to any method of determining elastic strength in which it is necessary to have a stress-strain diagram. Their objection is that such a method is too slow for commercial test conditions.

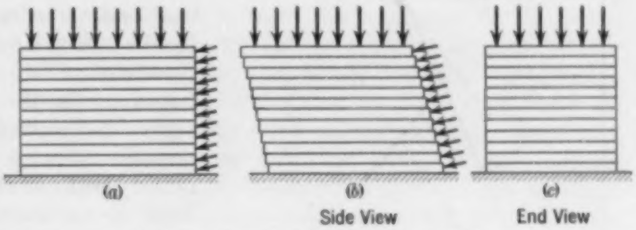


Fig. 2 Slip Action Illustrated by Diagrams of a Pile of Boards

It is true that if data of load and stretch are taken, reduced to data of stress and strain, plotted on cross-section paper, and then a diagram drawn to fit the plotted points, the process is indeed very slow. Autographic attachments for drawing stress-strain diagrams as the test proceeds are on the market but, in general, are too delicate for the rather rough usage of commercial laboratories.

It is possible, however, to take rapidly what are known as semi-autographic diagrams, using rugged apparatus. For taking such diagrams, the testing machine is equipped with a pencil attached to the poise of the weighing beam, or to the indicator of the weighing dial so that the motion of the pencil is in a straight line and is proportional in amount to the load applied. This pencil writes on the surface of a drum, or of a sliding table, which can be moved step by step in a direction perpendicular to the motion of the pencil. An observer watches the dial of the extensometer, and as the pointer passes a division on the dial he moves the drum, or sliding table, one step ahead. The result is a "stepped" diagram such as that shown in Fig. 5. A diagram of this type for a tension test of steel can be taken in less than five minutes.

SIGNIFICANCE OF ELASTIC STRENGTH

It is evident, then, that the determination of any limiting stress below which damage by inelastic action may be considered to be negligible, is a matter involving arbitrary tolerances. I believe that it is well to discard the idea of a "true" elastic limit for actual materials, and to have arbitrary tolerances for inelastic action frankly recognized and clearly stated for different

materials and for different services. The significance of any elastic strength determined by test differs for engineers with different viewpoints.

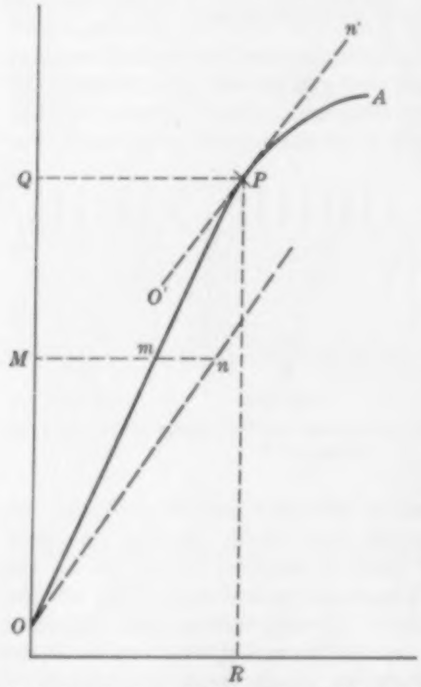


FIG. 4. JOHNSON'S METHOD FOR DETERMINING ELASTIC STRENGTH

To the theoretical elastician, the term elastic strength indicates a limiting stress beyond which a material departs markedly from Hooke's law, and computations based on the theory of elasticity become unsatisfactory because of their inexactness.

As a matter of fact, the computations of the elastician are, at best, correct only in a general "statistical" way, but they become seriously inexact when the law of proportionality of stress begins to fail.

The structural engineer is interested in yield strength as probably the most important index of the service of materials under steady loads, or under loads repeated only a few times. Especially is this yield strength important for compression members, and for beams whose compression flanges are not restrained from buckling under load. The structural engineer, too, wishes to determine yield strength by a method allowing rather large tolerances for inelastic action. The drop-of-the-beam yield point for structural steel gives him a very good index, if he can be sure that the method has been honestly as well as carefully applied.

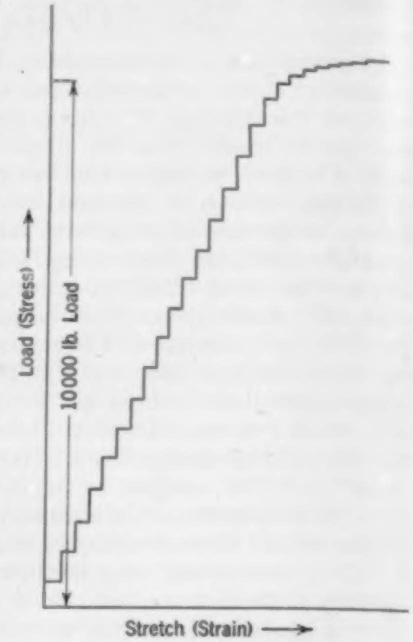


FIG. 5. SEMI-AUTOGRAPHIC STRESS-STRAIN DIAGRAM

To the machine designer, yield strength is of great importance, but in many machine parts it is secondary in value to the strength under repeated loading, "fatigue" strength as it is rather incorrectly called. For machine service, it is frequently desirable to determine yield strength by the use of closer tolerances than are needed for structural work.

To the testing engineer, yield strength represents an important test result, especially for ductile metals. He is interested in standardized, uniform methods of determining this—methods which will give significant values; and which will give concordant values when the tests are made in different laboratories, by different men, and on different testing machines.

GEORGIA SECTION HONORS PRESIDENT COLEMAN

On the occasion of his official visit to the Georgia Section, on October 16, President Coleman was entertained by this large group of local members.

Bridges Over Navigable Waters

Bridge Legislation Committee of American Engineering Council Reports on Present Status of Regulation

THIS recent report of the American Engineering Council's Committee on Bridge Legislation, is of peculiar value to engineers interested in the construction of toll bridges spanning navigable streams. After consideration, the Administrative Board of the Council approved the Committee's report and adopted its recommendations.

The original report, which was signed by H. S. Crocker, Chairman, V. H. Cochrane, A. H. Fuller, A. P. Greensfelder, F. M. Gunby, J. L. Harrington, and D. B. Steinman, all Members Am. Soc. C.E., has been here somewhat condensed and rearranged for publication. The pictures have been introduced to illustrate the type of structure covered in the report.

THE Federal Government has jurisdiction over all the navigable waters of the country by virtue of the Commerce Clause (Section 8, Article 3) of the Constitution. The Supreme Court has so held in numerous decisions and has also ruled that the jurisdiction of the Federal Government over navigable waters exists whether the Federal Government exercises it or not.

By decisions of the U.S. Supreme Court, it has been established that even if a State did assume control over a navigable stream within its borders for any purpose whatsoever, the Federal Government could thereafter exercise its jurisdiction, at which time the State's jurisdiction would cease and all laws passed by the State government relating thereto would become inoperative in so far, only, as they conflicted with the Federal statutes.

It has therefore been clearly established that the several States have no rights with respect to such matters when the Federal Government chooses to exercise its powers. It is important to bear this fact in mind when considering any problem associated with navigable waters.

RIVER AND HARBOR ACT OF 1899

The Federal Government has always declined to permit any obstacles or obstructions to be built in or over any navigable waters which might interfere with their free and safe use for the transportation of the Nation's commerce. It first exercised its general jurisdiction with respect to bridges in 1899.

Sections 9 and 10 of the River and Harbor Act of March 3, 1899, provide that all plans or modifications of plans for dams, bridges, or similar structures across any navigable waters of the United States must be approved by the Chief of Engineers and by the Secretary of War before being presented to Congress for its official consent to begin construction work, except that whenever the navigable waterway lies entirely within a State the authority of the State legislature may be substituted for the consent of Congress. It provides further that no work whatever shall be done on any navigable waterway or within any harbor except on plans recommended by the Chief of Engineers and authorized by the Secretary of War prior to the beginning of construction.

The courts have uniformly sustained this legislation.

In this act, Congress delegated to the several State legislatures the right to consent to and approve the construction of bridges over waterways, the navigable portions of which lie wholly within the borders of a single State. Bridges have been built under this authority. However, there are many both in and out of Congress who contend that this provision is unsound and ought to be repealed. There has been introduced in almost every Congress for some years a bill for that purpose. This is one of the most contested questions associated with bridge legislation.

GROWING NEED FOR BRIDGES

For many years in the early history of the United States, the bulk of interstate commerce was carried on by water transportation, so Federal legislation was enacted to safeguard and expedite this traffic. Then came the vast railroad development which led to the necessity for the construction of many railroad bridges. A recognition of the need for a change was manifested by the passage of a general bridge bill, March 23, 1906. Since this time the jurisdictional situation has been seriously complicated by the development of automotive transportation, which has required the building of thousands of miles of improved roads. This latter development has brought about a still greater need, with consequent demand for additional bridge legislation.

Fairchild Aerial Surveys, Inc., N.Y.

MT. HOPE BRIDGE
Privately Owned Vehicular Structure, Bristol to Portsmouth, R.I.

The act of 1906 delegated to the Secretary of War and the

Chief of Engineers, U.S.A., the duty of examining and approving the plans and specifications of all bridges thereafter constructed over navigable waters, and the settlement of all engineering and other technical questions connected therewith. This task has been performed with efficiency and high regard for the public interest, but until recently with a primary regard for the interests of navigation.

The growing importance of highway transportation has lately been given recognition by the present Chief of Engineers in the issuance of instructions that due and proper weight must be given in the consideration of bridge permits to the traffic both over and under the bridge. This is a forward step because in the past too frequently consideration has been given only to the possibilities of traffic under the bridge.

Photograph Eddy

BRIDGE OF THE GODS
Privately Owned Vehicular Structure Spans Columbia River

As important as are the interests of navigation, the chief concern of many citizens of the United States has shifted to those agencies which facilitate cheap and rapid automotive transportation. Thus, to many, the traffic value of a bridge far transcends any consideration of water transportation existing or imagined.

Congress determines as to whether or not a proposed bridge shall be authorized when and where requested, and the restrictions under which the builders of the bridge may operate it. Since the 1906 Bridge Act, Congress has not attempted to prescribe by legislation any detailed specifications for the construction of bridges.

For purposes of clarity, bridge permits may be divided into three classes, those for (1) bridges over interstate navigable waters, (2) bridges over intra-state navigable waters, and (3) bridges over unnavigable waters. Under the present law, if it is desired to build a bridge in Class 1, a bill must be passed by Congress authorizing the bridge. The Secretary of War and the Chief of Engineers will not issue a permit for the construction of a bridge over navigable waters until Congress has passed such an enabling act, authorizing the bridge. If the State authorities are required to pass upon the project, this action must be taken before the plans are submitted to the Secretary of War and the Chief of Engineers for approval.

If the bridge falls in Class 2, no enabling act of Congress is necessary. Only the State laws and regulations need be complied with prior to the submission of plans to the War Department. If it is desired to build a bridge of Class 3 type, only the laws of the particular State must be complied with.

BRIDGE AUTHORIZATIONS GRANTED

As an indication of the attitude of the last (Seventy-first) Congress toward bridge legislation, a study has been made of the legislation which passed either one or both Houses in the first and second sessions.

BRIDGE LEGISLATION SEVENTY-FIRST CONGRESS, FIRST AND SECOND SESSIONS

	Bills Considered	Laws Passed	Per Cent Becoming Law
Publicly owned free bridges	76	71	93.5
Publicly owned toll bridges	6	4	66.7
Privately owned toll bridges	31	20	64.5
Granting extension of time	57	53	93.0
Railroad bridges	10	10	100.0
Tunnels, special, miscellaneous, general	16	8	50.0
Duplications	29	..	....
Total	225	166	73.7

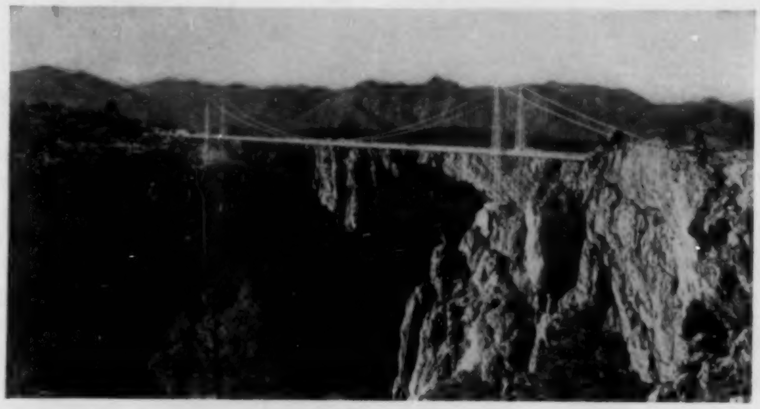
By duplications is meant that a similar bill was introduced, perhaps simultaneously in both Houses and subsequently one bill was dropped and the other substituted for it, or perhaps it was placed in an omnibus bill such as H.R. 9806.

This indicates that a railroad bridge bill is almost certain to be passed. It is also almost certain that Congress will give its consent to a publicly owned free bridge,

PHILADELPHIA–CAMDEN BRIDGE OVER THE DELAWARE RIVER
Publicly Owned Bridge Connects Pennsylvania and New Jersey

as is indicated by the 93.5 per cent. A number of these publicly owned free bridge bills which were not enacted into law during the past session will undoubtedly be passed. It is also almost certain that Congress, after it has granted permission for the construction of a bridge, will in the event of a legitimate reason, grant an extension of time for its beginning or completion. This is shown by the large percentage of bills granting extension of time which actually became law.

No conclusive evidence can be drawn from the other percentages. However, it is notable that practically all of the 20 bills for privately owned toll bridges which were enacted into law, were so enacted in omnibus bills, and in every case were surrounded by very stringent recapture clauses (see Public Law 330, Seventy-first Congress). Less than 20 per cent of the bridges authorized by the Seventy-first Congress were privately owned toll bridges.



Royal Gorge Bridge

Privately Owned Vehicular Bridge Over the Colorado River, Colo.

Previous Congresses have had the following record on this subject:

Bridge Legislation

Congress	Total Bridge Bills	Total Becoming Law	Per Cent
67th	164	113	69
68th	219	165	75.4
69th	290	193	66.6
70th	478	376	78.5

TOLL BRIDGE HISTORY

Since the Secretary of War and Chief of Engineers exercise jurisdiction only over navigable waters, it becomes of great importance at the outset whether or not a given stream is navigable. A stream may be legally navigable and it may or may not be navigable in fact. If a stream has been declared navigable by law, a decision may be obtained from the courts which will nullify the law. If the stream is or has been used for transportation or is readily susceptible of such use, there is no doubt concerning its navigability.

In the early development of the United States, many of the main roads were toll roads and most of the stream crossings were by means of ferries where, in every case, a toll was charged. These ferries took the place of bridges.

Prior to 1920, there were only two or three toll bridges built per year. During 1920 there were 5, which number increased to 24 in 1927. The grand total of toll bridges in operation and proposed up to October 1927, was 425, of which 311 were privately, and 114 publicly owned.

On October 1, 1927, there were in operation in the United States 233 toll bridges, 29 under construction, and 163 proposed—a grand total of 425. Of the 29 bridges under construction, 20 were privately owned and 9 publicly owned; of the 163 proposed, 100 were to be privately owned and 63 publicly owned.

P. K. Schuyler, M. Am. Soc. C.E., is the authority for the statement that the number of toll bridges in operation on August 1, 1930 were:

Publicly owned	62
Privately owned	234
Total	296

There are now under construction about 58 toll bridges and approximately 350 proposed, of which a very small percentage will materialize. This is largely due to present economic conditions and to the difficulties of financing in the face of adverse legislation threatened by Congress. The American public does not like to pay a direct toll for the use of such a public convenience as a bridge, and there are a number of Congressmen who try to prevent the granting of authority for toll bridges.

This attitude is maintained in spite of the fact that almost every State levies a gasoline tax which is used for

American Commercial Photo Co., Detroit

Ambassador Bridge Over the Detroit River

Privately Owned Vehicular Bridge Connects Detroit and Windsor, Canada

road construction and maintenance so that every motorist pays, in a sense, about one-half cent per mile for the use of the roads. Furthermore, were it not for toll bridges, in many cases, the old inefficient, unsafe, and slow ferries, for which a toll was always charged, would still be in use. In this connection it may be noted that the advocates of free bridges are strangely silent in regard to these ferries.

There are cases on record of the exploitation of permits to build toll bridges. In some cases the cost of construction and financing has been watered or inflated, making the cost excessive to the public when it has desired to purchase such bridges. These circumstances have led to discontent and dissatisfaction with the present toll bridge situation. This must be corrected.

TOLL BRIDGE FINANCING

During 1927, the return on the investment from privately owned bridges averaged 13.9 per cent and the return from publicly owned, 8 per cent. The total investment in toll bridges was then divided as follows:

Publicly Owned:	
In operation	$45,178,000
Under construction .	74,530,000
Proposed	58,243,000
Privately Owned:	
In operation	73,176,000
Under construction .	41,293,000
Proposed	254,710,000
Total . . .	$547,130,000

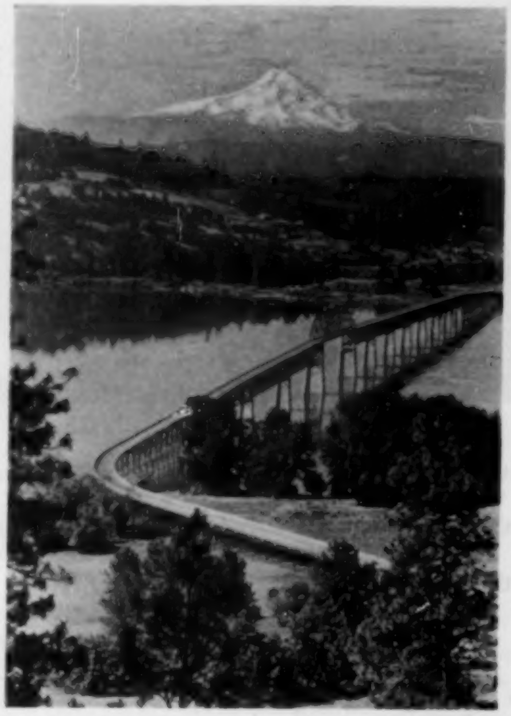


Photo Gifford

INTERSTATE BRIDGE
Privately Owned Highway Structure Spans Columbia River at Hood River, Ore.

For the bridges in operation, both privately and publicly owned, the capital invested was $118,354,000. The operating cost for all of these bridges was $13,809,000, or 11.7 per cent of the cost. The figures for August 1, 1930, given above, compare with those of October 1, 1927, as follows:

Year	Total Toll Bridges	Privately Owned	Per Cent of Increase	Publicly Owned	Per Cent of Increase
1927	233	191	. .	42	. .
1930	296	234	18	62	32

PROTECTING THE PUBLIC

Under existing laws, the public has the following protection against excessive tolls and toll-bridge exploitation over navigable waters. First, any citizen or group of citizens can appeal to the Secretary of War for an investigation and a readjustment of toll charges over any bridge built in 1906 or after, and over some bridges built even before that date. The Secretary of War has authority to investigate and readjust tolls to a fair standard. Past records indicate that this authority has been exercised fairly and judiciously in the public interest. In the last five years there were 19 complaints because of excessive toll charges and the Secretary of War settled 18 of these without resort to court action.

In addition to this protection, in a number of States where toll bridges are classed as public utilities under the State public service enactments, the rates and services rendered by these bridges are subject to the jurisdiction of the State public service commissions.

Second, any political subdivision such as a city, county, or State may apply for a permit to construct a free bridge at or near the same site where the toll bridge exists. The policy of Congress has been, and is, to grant such permits. True, the Secretary of War and Chief of Engineers have in the past frowned upon such procedure on the ground that numerous and needless bridges interfere with navigation. Certainly it seems just that some agency should be charged with the responsibility of protecting the investments of the public in privately owned toll bridges which are already adequately serving the needs of transportation. However, more liberal consideration has been given to this phase of the problem in the last year.

It follows that when the management of a toll bridge company is fully aware that a contributing community can and will, if necessary, build a free bridge at a given site, it becomes more susceptible to a reasonable charge for its bridges, either as a proposition for recapture or in regard to rate of tolls to be charged. The vast majority of private toll-bridge companies recognize that a reasonable toll charge promotes the use of the bridge and hence, in the long run, produces more revenue than can be had by charging excessive rates.

OBJECTIONS TO GRANTING BRIDGE FRANCHISES

The feeling of those concerned with bridge legislation is exemplified by the following objections which have been raised to the present system of granting bridge franchises. These objections did not originate with this Committee but many of them appear to have sound reason back of them.

The existing method permits toll charges to be based on an inflated valuation of the structure. In recapture, toll companies have demanded prices far in excess of the cost of the bridges built by them. State highway authorities and toll bridge companies have been unable to agree on the location of roads and possible competing free bridges. The laws do not definitely set forth the factors which should be considered in a fair valuation of the bridge and therefore the amount of income to which the company is entitled.

It is not now possible for the Corps of Engineers to ascertain the cost of a toll bridge until 90 days after its completion, which may be too late to discover discrepancies in cost figures. It is not uncommon for a bridge to cost up to $50,000,000, and States sometimes

SCIOTOVILLE BRIDGE
Chesapeake and Ohio Northern Railway Crosses Ohio River

CARLTON BRIDGE OVER THE KENNEBEC RIVER, BATH, MAINE
Railroad Below and Highway Above

COOPER RIVER HIGHWAY BRIDGE
Spanning the River at Charleston, S.C.

GRAND' MERE BRIDGE
Publicly Owned Vehicular Bridge Over the St. Maurice River, Canada. An Example of Bridge Construction where Provision Is Not Made for Navigation.

CARQUINEZ BRIDGE, CARQUINEZ STRAIT, CAL.
Highway Toll Bridge, Originally Private, Now Publicly Owned

WHAT TOLL BRIDGES REPLACE
Ferry Across Missouri River Now Replaced by Toll Structure

have difficulty in financing such a structure. However, a privately owned toll bridge should be considered as a public utility subject to public regulation like any other public utility. This is not now generally the case.

Under Congressional authorization, the owner of a toll bridge is given no protection against unfair competition and there are examples where competing bridges were constructed which were unnecessary and economically unjustified. The existing bridge laws need simplification, codification, and unification. For these and other reasons Congress, the public, those financing and building bridges, the Corps of Engineers, the Bureau of Public Roads, and the Lighthouse Service all feel that in some particular or other the present situation should be improved.

PORTSMOUTH BRIDGE
Privately Owned Vehicular Bridge Over the Ohio River, Ohio

Some of the arguments presented by the supporters of the Denison bill are here stated. New legislation and a codification of the existing laws are needed because of the changes which have occurred since the enactment of the last general bridge legislation, 24 years ago. There is no essential difference in the proposed bill and the present general procedure followed by Congress, the Secretary of War, and the Chief of Engineers, and it would therefore be helpful to have the policy enacted into law. A clear understanding of the future of toll bridges is necessary to encourage the investment of American capital in these useful public utilities. It is claimed that the proposed Denison bill would materially lessen the exploitation of unworthy toll-bridge schemes and would protect the interests of the public.

The Committee feels that, on the other hand, the proposed legislation will not help the bridge situation unless it is materially and radically altered, and that, in its present form, most of it would be positively injurious. The recapture clause is unusually severe and in operation would undoubtedly prevent the financing of privately owned toll bridges.

Too much authority is conferred on a single Government department, the War Department, represented by the Secretary of War and the Chief of Engineers. It makes no provision for concurrent jurisdiction by the Bureau of Public Roads through the Secretary of Agriculture, and the Lighthouse Service, through the Secretary of Commerce, in the case of bridges over which they now indirectly exercise control. The terms of the bill grant the right, without charge therefore, to construct, and maintain private telephone and telegraph lines across toll bridges. Specific objections of some kind or another have been made by some member of this committee to almost every section of the bill.

GUIDING PRINCIPLES IN FRAMING LEGISLATION

The consideration of new legislation for toll-bridge construction should be guided by certain definite principles. Private capital should be encouraged to construct them, but toll-bridge authorization should not be granted unless local authorities are on record as being unwilling to construct a free bridge. No unreasonable limitations should be prescribed on either financing, design, construction, or maintenance of a bridge.

Provisions should be made for filing an itemized and sworn statement of the cost of bridges, but recapture should not be permitted within 20 years after completion of the structure. Consideration of transportation over the bridge should be equal to that given to navigation under or through it. The administrative authority should be required to furnish, upon request, the necessary horizontal and vertical clearances over navigable streams at any given point prior to submission of plans.

Bridge permits having the general nature of a franchise should be obtainable without an act of Congress. The law should include provision for reversion of toll bridges to States within a liberal time. The States and State highway commissions should be given as much authority as possible and the framing of the law should prevent the nefarious practice known as "bridge franchise peddling."

RECOMMENDATION

From a study of the pending legislation and the arguments raised in connection with it, this Committee concludes that the present system of granting bridge franchises is a haphazard evolution of methods applicable before the advent of motor transportation and permanent surface highways. The system involves a great waste of time and protects neither the interests of the public nor the investments of those who build the bridges. Engineering Council should take measures to acquaint the engineering profession with the situation, and to extend its assistance to Congress and the Federal departments affected in the preparation of suitable legislation that will not only correct the present evils but also facilitate construction of private and public toll bridges.

Because legislation now being considered may be enacted in the December session of Congress, the Committee recommends that Engineering Council take immediate steps as follows:

First, that it place itself upon record as opposing H.R. 7879, known as the Denison bill, and all other similar bills until the situation can be more thoroughly studied and more compact and satisfactory legislation be secured;

Second, that the President of the Council be authorized to increase the personnel of this Committee upon request of the Chairman;

Third, that the Executive Secretary and Chairman of this Committee be authorized to appear before Congressional committees and at other public hearings in support of the general principles and conclusions herein set forth.

New Method of Mechanical Analysis for Trusses

By Anders H. Bull

Member American Society of Civil Engineers

Assistant Engineer, Board of Transportation, City of New York

DEVICES for studying stresses in intricate structures by mechanical means are not new. But Mr. Bull's apparatus is different from the rest. It accounts for the axial flexibility of members. In this it provides what structural engineers consider an ingenious and unique method. Originally delivered before the Brooklyn Engineers Club, New York, on October 9, 1930, in discussion of a talk by Prof. George E. Beggs, it is here reproduced for the benefit of our readers.

MECHANICAL means of stress analysis, as first applied by Professor Beggs in his deformeter method, are much in vogue today and are extensively applied to some of the more difficult types of engineering structures. Indeed, they are at least supplementing, if not largely supplanting, rigid mathematical methods.

Anyone familiar with the deformeter method must have been impressed with the wonderful results obtained by the simplest of means, which is, in the end, the true criterion of greatness. It presents a wide field of usefulness and yet there are some types of indeterminate problems to which it is not well adapted.

Take, for instance, the case of a truss, say a pin-connected Warren truss, resting on three supports, as seen in Fig. 1. It would not do to cut a model from a cardboard or celluloid sheet showing the individual tension and compression members in widths proportional to their areas and test it, by the deformeter method. In the first place, the stiffness of the joints would give rise to high secondary stresses which are likely to vitiate the results. Then, too, it would be difficult to guard against buckling of the compression members and warping of the model.

A PRACTICAL DIFFICULTY

An example of more monumental character also emphasizes the difficulty. The deformeter apparatus had been considered for analyzing the stresses in the towers of the Hudson River Bridge, between Fort Washington, N.Y., and Fort Lee, N.J., the question having arisen as to whether the lateral position of suspension cables should be at the center of each of the twin side towers or in toward the center line of the bridge. The latter location was of advantage in that it permitted the members supporting the bridge floor to be shortened, resulting in a substantial saving of steel. At the same time, placing the cables to one side might cause the reactions at the foot of the four tower legs to become too unequal. It was decided that the deformeter apparatus was not suited for the problem in question, so a true model of the towers was made to a small scale and tested by means of a strain gage. To avoid warping, the model was turned upside down and stretched by hanging weights on it, the results of the tests confirming the results which were analytically obtained.

WHAT IS IDEAL MODEL FOR TRUSSES?

How, then, are we to make models of trussed or latticed structures permitting them to be analyzed mechanically as readily as are arches and simple frames, preferably models that can stand deflections large enough to be measured with an ordinary scale without recourse to microscopes?

In studying the physical problem presented, it was at once clear that if, under axial forces of tension or compression, the flexibility of corresponding members in the model and in the structure were made proportional, the basic requirement for a mechanical analysis would be fulfilled. The difficulty was to find a type of member that would be flexible axially and still have sufficient rigidity laterally to prevent its buckling.

A first attempt comprised an arrangement of helical springs mounted in frames and attached to wires sliding inside the helixes. This was abandoned because of internal friction. The second attempt proved more successful. The type of member used is entirely frictionless and may be given any desired axial flexibility while retaining lateral stiffness. Its construction is shown in Fig. 2.

Four flat brass springs, *f*, were perforated by means of a hand punch, three holes being made on the center line of each, using templates to secure an even spacing. Mounting the springs in a "jig," two pieces, *a*, of stout

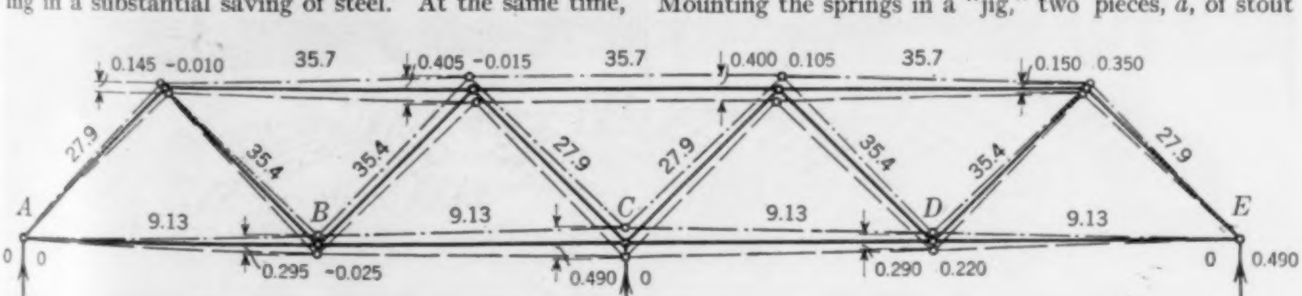


Fig. 1. A Pin-Connected Warren Truss Giving Deflections of Model and L/A Values

brass wire were put through the holes at the ends and two other pieces, *b*, of the same size wire, through the center holes of each two of the springs. The springs and wires were then secured in position by means of soft solder. The wires, *b*, are thus automatically aligned, and a force applied along their common axis will bring them further apart or nearer together by an amount depending on the dimensions and modulus of elasticity of the springs. The axial flexibility of the wires themselves is, of course, negligible. The necessary lateral rigidity of the member is secured by the resistance offered by the springs to bending in their own plane and by the stiffness of the wires.

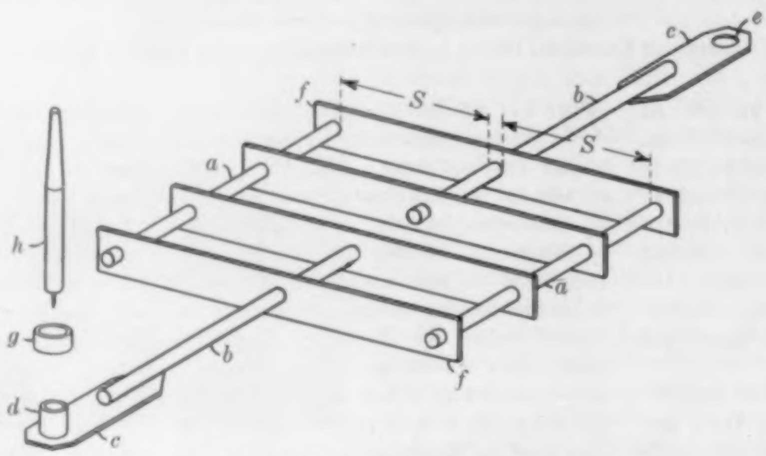


FIG. 2. MEMBER MADE OF FOUR FLAT BRASS SPRINGS

As the springs were all cut from the same coil, their modulus of elasticity was assumed to be the same. For any member, the required flexibility may be attained by properly selecting the length, *S*, the clear distance between the wires. The soldering makes the springs practically fixed at their junction with the wires.

The deflection of a flat spring being proportional to the cube of its length, the flexibility of any member in the model will be in proportion to S^3, whereas that of any member in the structure is in proportion to the ratio of *L*, the length, to *A*, the area of the member. This means tnat in each member of the model, *S* must be made proportional to the cube root of the $\frac{L}{A}$ value of the corresponding member in the structure.

For demonstration purposes, the simple structure shown in Fig. 1 has been chosen, the $\frac{L}{A}$ value of each member being indicated at its center. The web members are supposed to be inclined at an angle of 45 deg. and the three supports, *A*, *C*, and *E*, to be of equal height.

MAKING THE MODEL

In building up the model, which has a total span of 30 in., the members are cut to proper length and the ends of wires, *b*, Fig. 2, soldered to plates, *c*. The plates have holes, *e*, into some of which are soldered hollow pins, *d*, fitting closely and permitting the members to be packed at the panel points. These operations were likewise done in jigs to insure that the pins and holes were being properly aligned; that each member was made of the correct length, and that the packing pins were placed at right angles to the plates.

After packing, in order to hold the members tight, ferrules, *g*, were slipped over the pins, *d*, and secured in place by means of a drop of solder. The fit proved satisfactory, allowing no appreciable play in the model. After assembly, the model appeared as shown in the photograph.

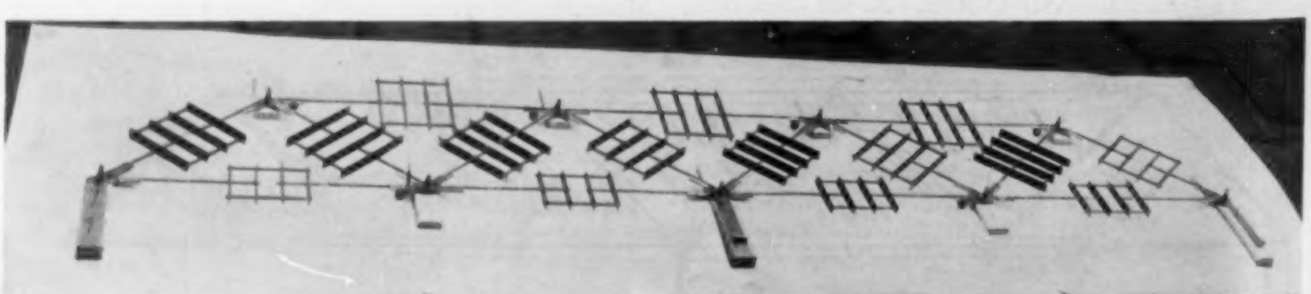
For marking the deflected position of each joint or panel point on displacing a support, a turned steel point, *h*, of the kind used in drafting instruments, was employed. The steel point closely fits the inside of the hollow pin, *d*. Inserting it carefully, shoulder end down, and tapping it slightly makes a small hole in the paper under the model.

To reduce the friction, $^1/_4$-in. brass balls were placed between the model and the paper, near all the joints except those at the supports. The deflected position of the joints was recorded on paper glued to the top of small wooden blocks placed just under the joints.

At the supports, the model was held by brass strips packed with the members and secured to wooden blocks. One of these strips was fastened with two brads, the others with only one each, giving the model the necessary freedom of movement so as to avoid any horizontal restraint, for which purpose rollers or rockers are generally used in the structure.

DETERMINATION OF REACTIONS

For first determining the reaction at the center support, joint *C* was displaced vertically by equal amounts to either side of the unstressed position and the corresponding displacement of each joint, including *C*, recorded with the steel point. The deflection, which for vertical loading is defined by Maxwell's theorem as the



THE COMPLETED MODEL

vertical component of the displacement, is indicated in Fig. 1 at the left of each joint. Similarly, the readings to the right indicate the deflections obtained for a displacement of joint E. From these the reaction at the right end support may be determined.

The mechanical analysis is based on the simple rule that the reaction produced at a support by a unit load applied at any point is equal to the deflection at that point, as above interpreted, divided by the displacement at the support. On the basis of the deflections shown in Fig. 1, we therefore have, for a unit load applied at one of the quarter points, the reactions:

$$R_A = \frac{0.220}{0.490} = 0.449; \quad R_C = \frac{0.290 + 0.295}{2 \times 0.490} = 0.597;$$

$$R_E = \frac{-0.025}{0.490} = -0.051.$$ The analytical values are, respectively, 0.442, 0.616, and -0.058.

Applying a uniform load, P, over the whole span, is equivalent to placing loads of $\frac{P}{4}$ at each of the panel points, B, C, and D, and of $\frac{P}{8}$ at points A and E, resulting in the following reactions:

$$R_C = \frac{0.295 + 0.490 + 0.290}{0.490} \times \frac{P}{4} = 0.548\ P;$$

$$R_A = R_E = \left(\frac{-0.025 + 0 + 0.220}{0.490} \times \frac{P}{4}\right) + \frac{P}{8} = 0.224\ P;$$

as compared with analytical values of 0.558 P and 0.221 P, respectively. No doubt the errors in the values obtained mechanically, up to 2 per cent of the load, are largely due to the crudeness of the model. For more accurate results, the members should be gaged individually by measuring their extension and compression under a given load instead of relying solely on the length of the springs, as was done in this case.

An objection may be raised that models of this type would be too elaborate for practical use. It should be borne in mind, however, that the analytical treatment of indeterminate structures of the trussed type is, as a rule extremely involved, making an independent check of considerable value, and well justifying the employment of a competent mechanic to build an accurate model.

Kill van Kull Arch Closed

In the March 1930 Proceedings is a complete description of the design and proposed erection methods for the Kill van Kull vehicular bridge spanning the estuary between the southern tip of the Bayonne Peninsula, N.J., and Staten Island. The lower chord of this steel arch, 1,652 ft. between pins, was closed on October 4, 1930. The illustration, furnished by the Port of New York Authority, shows the traveler placing the closing upper-chord members. Between the erection bents shown lies the deep-water channel, within which no supports were placed. The cantilever erection extended 10 panels, or 413 ft., beyond the higher erection bent and required a toggle truss strengthener to relieve stresses in members adjacent to it. One of the erection bents is being dismantled and the foundation supports of several others used on the right arm may be noted.

Highway Transport Problems

Commercial Traffic Develops Highway Plans

By Maxwell Halsey

Traffic Engineer, Massachusetts Department of Public Works

The importance of highways, so necessary to the expansion of intercommunication between centers of production and consumption, was recently emphasized by the gathering of technical representatives from nearly every country in the world at the Sixth International Road Congress in Washington, D.C. The Nation's prosperity is dependent upon the improvement of highways. The Massachusetts highway system has been developed by pioneers in the work, and the experience that Mr. Halsey brings to the highway engineer from that great commonwealth cannot fail to be of unusual benefit. This paper was read at the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education at Yale University on July 18, 1930.

THE term "highway transport," as I shall use it in this paper, refers to commercial traffic, including vehicles such as trucks and buses but not ordinary passenger cars. My chief purpose is to show the relative position of highway transport in the traffic picture, and to indicate some of the provisions which must be made for it in the future, with emphasis on the control problem.

One index of the growing use of commercial vehicles is the numerical increase. Some of the causes of this increase should be considered, for they indicate what we may expect in the future. Perhaps the chief cause has been the improvement in transportation units and in highways, for while rough, hilly roads did not present insurmountable obstacles to passenger cars used for pleasure, they were economically unfavorable for heavy loads. It was not until highways had been vastly improved and reliable vehicles capable of carrying heavy loads were developed, that the growth of commercial traffic really began.

ECONOMIC BASIS OF GROWTH

Commercial traffic appears to have developed upon a strictly economic basis, for as soon as goods could be transported more cheaply over the highways these routes were used. The development of more highway than rail routes caused an immediate increase in highway transport. The early "jitney" was more convenient than the street car, because newly developed localities frequently lacked car tracks. The free-wheel advantage, then, added materially to the increase in commercial highway traffic.

A later development of this was the door-to-door delivery now being offered by shipping and hauling concerns. Still another advantage of this form of transportation is 24-hour service, and many factories are using trucks for no other reason than this. The growing monetary value of time is thus aiding highway transport. Any movement toward a decentralization of industry, which economists have lately been suggesting, would have the same result.

Since delay in transport is costly, there is a growing tendency to use commercial vehicles during the "off-peak" hours when there is less traffic congestion. A Chicago carrier, doing night hauling, operates at half the cost of day haulage and uses fewer trucks. It is apparent, then, that the greater the number of miles each unit can travel in a given period, the fewer the units and, therefore, the less capital needed. In the future, carriers of highway transport will permit their units to lie idle only for the time necessary to maintain schedules and repairs.

SIZE OF TRUCKS AND BUSES

Considered from the viewpoint of efficiency, the size as well as the use of a commercial vehicle is important. There is a continual debate concerning the comparative efficiency of large units, which are necessarily slower, and small units, which are faster but cannot carry such large loads. A consideration of cost per pound per mile, as well as of loading and unloading charges, would seem to favor the larger unit. It has, however, two disadvantages. The first is the problem of consistently obtaining full loads and the second, the comparative slowness and unwieldy character of large vehicles. The problem of vehicle design has, however, already been solved to a large extent. The new vehicles on display and on the road seem to indicate a compromise between large and small capacities, with the speed of the small unit. From the viewpoint of loading facilities, the small or medium-sized unit has its advantages.

The character of the highways also imposes limits on the size of vehicles. The whole highway system today is based upon the principle of lanes 10 ft. in width, which very definitely limits the width of commercial units. The present 8-ft. limit in Massachusetts is practically the maximum. It is useless for the exponents of a 9-ft. limit to argue that a 9-ft. vehicle can operate in a 10-ft. lane. While this is possible, it is not practicable, for the highways are full of drivers who are not as expert as trained commercial operators and are much more timid. The fear of being "squeezed" on the highway is just the sort of "friction" which will inevitably slow up traffic. If there were real need for wider units, then wider lanes would be required. Since this would cause a waste of highway space in the case of private passenger vehicles, which will always predominate, the present lane width is the more efficient.

MANEUVERABILITY A FACTOR

The development of greater weight-carrying capacity by using longer bodies or trailers is limited to some extent by the factor of maneuverability. It is quite possible that the development of pneumatic tires will enable heavier loads to be carried with less damage to the highways.

Discussion of the commercial units themselves should be followed by a consideration of the highways which are designed to carry them. Unfortunately, many routes were laid out and built before the importance of highway transport made itself apparent, and for this reason are not suitable for commercial traffic.

Fortunately, most of the improvements which benefit the truck and bus traffic are also of great aid to the driving public, and all users of the highways can unite in a common cause. It is not my intent to discuss the relative value of different materials for road construction; I merely wish to point out the necessity for considering commercial traffic when constructing roads. Heavily used commercial routes should be known and should be so built that they are adapted to this purpose.

The reduction of grades and the modification of sharp curves are two improvements which will do much to make highways more attractive to commercial traffic. Many, though direct, have such grades as to keep off commercial traffic, while others are level but winding.

Much can be done to assist highway traffic by the expansion of highway systems to provide direct routes between points which have a considerable interchange of commodities and persons. The need for a direct route between two cities is certainly greatest when large amounts of commercial traffic are involved.

Wherever high-speed, trunk-line highways go through cities, service roads should be provided for the parking and unloading of commercial or other vehicles. These service roads or drives should be separated from the main road by "island strips" or parkways where possible. Obviously, to be of value, commercial vehicles must load and unload, and this cannot be done in safety close to high-speed movements.

PASSING A PROBLEM

The layman's chief contact with commercial vehicles is usually his attempt to pass them and, unfortunately, this is often an unpleasant experience. Commercial units cannot have the same maneuverability as passenger cars, and, therefore, there must be continuous passing. It is not sufficient to say that a truck or a bus is more important than a passenger car because it is on business, or because it carries many times more merchandise or passengers. In the first place, passenger cars are not necessarily pleasure cars; they are often on business. In the second place, there will always be more passenger cars than there are trucks and buses, and the continual friction between the two groups will tend to slow down the stream of vehicles and thus delay all. The passing which occurs between the more slowly moving vehicles—which are trucks and frequently buses—and passenger cars is an important element which must be allowed for in highway design. Inability to pass safely has limited the capacity of a great number of highways.

Since passing is necessary, let us consider the best way to accomplish it. The first need is for sufficient room. On a very lightly traveled highway two lanes permit passing, but as soon as movement in each direction becomes fairly continuous, no passing can take place. With three lanes, passing can take place in one direction while continuous one-lane movement continues in each direction. Three lanes will serve fairly heavy traffic conditions, because there is not a constant demand for passing in both directions. Under a morning condition most of the passing demand will be in one direction, and during the off-peak condition the volume of traffic will have dropped so as to permit intermittent passing in both directions. In the evening, peak conditions of the morning are frequently reversed, and there is again demand for passing in only one direction. If the volume of traffic becomes still heavier, and there is a constant demand for passing in both directions, the three-lane highway is not adequate and four lanes become necessary. This statement of highway capacity is based on the assumption that there is no parking and that the slower moving vehicles remain in the right-hand lane. The parking situation may be cared for by providing improved shoulders for parking for, unless shoulders are attractive, motorists will park on the improved lanes.

Dual-Type Highway, Sudbury, Mass.
Cars Passing on Curve

Keeping slowly moving vehicles to the right is one of the serious problems confronting us today, and the rule concerning it is one of the most poorly enforced regulations in the country. Why do not the slowly moving vehicles keep to the right? Driving on the side of the older roads with a high crown meant that truck operators had to hold onto the old reversible type of steering wheel with both hands to keep the vehicle out of the ditch. Drivers of passenger cars were frequently a little afraid to drive on an angle and hated to be too close to any ditch; and in wet weather both truck and passenger car operators drove on top for safety. Modern highways have so little crown, and non-reversible steering wheels require so little effort, that this reason no longer holds. The second, and by far the most important reason, is that the surfaces of the right-hand lanes are frequently not so smooth and attractive as those of the center lane or lanes. An important principle of highway travel is that traffic will proceed upon the most attractive surface to be found.

Now why are the right-hand lanes less smooth in surface than the center lane or lanes? There are several reasons. First, the shoulder frequently breaks down and wears out before the center of the highway. Second, street car tracks are usually built in the center, and if the whole road is rough there is a temptation to ride the rails. Frequently, too, the street car company lays smoother or more enduring pavement than the community. Third,

the center lanes are often repaired more frequently, instead of, or in a better manner, than the side lanes.

However, even when all lanes have surfaces of equal attractiveness, we frequently find that trucks, buses, and other slowly moving vehicles insist upon driving in the center lane in spite of all lines, signs, and enforcing agencies. There is a certain amount of psychology involved in this failure to keep to the right. A consideration of some of the possible difficulties may show why operators act the way they do, and may indicate methods of improvement. If the shoulder of the road is not fairly wide, the outside lane may appear to the driver to be too close to the ditch or guard rail for comfort. Motorists will not drive close to fixed objects at high speed. Cars may park along the edge of the road, and motorists are afraid to drive close to them at high speed for fear that a pedestrian might unexpectedly step from between them, or that a parked car might suddenly turn out into the road. Frequently, a few commercial and other slowly moving vehicles driving on the right-hand side of the road will make the motorist traveling at medium speed use the center lane rather than weave in and out again. It appears to be much easier to stay in the center lane than to turn out to pass anyone. And then there are the slow driving, cautious motorists who continue in the center lanes even when there is absolutely nothing to prevent their using the right-hand lane. Perhaps they are used to two-lane highways and expect to drive next to the center line.

DUAL-TYPE HIGHWAY, WELLESLEY, MASS.
10-Ft. Macadam and Concrete Lanes, and Wide Shoulders

KEEPING SLOW TRAFFIC TO THE RIGHT

In considering a way to facilitate passing by keeping the slow moving traffic to the right, the most obvious method is to provide the necessary room, erect signs, paint lane lines, and then employ motorcycle officers to obtain enforcement. This method would undoubtedly work and illustrates one of the benefits of motorized patrol, but traffic officers are costly and it is economically almost impossible to use enough of them to develop such a driving habit unassisted.

The best way to attack the problem is, first, to provide the necessary room, three or four moving lanes adequately protected from parking by improved shoulders and shoulder room; second, to paint adequate lane lines and erect signs, and last, but not least, to provide the right-hand lanes, which the slowly moving traffic is expected to use, with surfaces not merely as attractive as those of the center lanes but far more so. If this is done, traffic will follow the line of least resistance, and automatically keep to the right.

Several pieces of road designed along these lines have been constructed throughout the country. Those in Massachusetts are of the "dual" type, and have outside lanes of cement and center lanes of macadam. Driving upon the macadam gives a slight vibration and a rumble, caused to some extent by the use of balloon tires. The lanes are clearly marked by the joints and by the contrast between the light color of the cement and the dark color of the macadam. Those in Massachusetts have been very successful. It is common to be able to look down the center of a three-lane, dual-type road and see no cars on the center lane except those actually passing.

ROAD CAPACITY LIMITED BY USE

On an ordinary three-lane road of either cement or macadam, even though laned and signed, it is usual to see two lanes of vehicles driving right next to the center line, or where this would be if the road were marked. Actually, on many four-lane highways composed of one type of pavement, it is an ordinary sight to see only two moving lanes of traffic, both using the two center lanes. This, of course, necessitates passing to the right, which is hazardous because the drivers in the center may pull over to the right and force the passer into the ditch.

The capacity of highways, between intersections, is limited by the use made of each lane. If a three-lane, 30-ft. highway carries only two moving lanes traveling adjacent to the center line, then it has not much more capacity than a 20-ft., two-lane highway. And in the same way, if a four-lane highway carries only two moving lanes or their equivalent in scattered flow, it does not carry much more than the two-lane highway, and certainly not as much as a three-lane dual type with two moving lanes of traffic and a center lane kept open for passing. It is obvious that the four-lane dual type provides a greater capacity by keeping two moving lanes and reserving two center lanes for passing in both directions. It is questionable whether it is efficient to go beyond this. Where six lanes are provided, they are seldom if ever used efficiently. If four-lane highways are provided with grade separations at all important crossroads, so that practically continuous movement can be maintained, their potential capacity of from 6,000 to 8,000 vehicles per hour would take care of great densities of traffic. Since, beyond a certain point, increased lanes bring decreased efficiency per lane, it might be better to provide alternative routes rather than to concentrate the traffic and obtain poor lane efficiency, an obvious waste of highway. The only conditions which appear to warrant six or more lane highways are those where exceedingly heavy volumes and varied types of vehicles exist, or where flows are heavy and concentrated in peaks, so that it may be advisable to use an unbalanced flow, four lanes in one direction and two in the other during the morning peak, and the opposite at night. The element of cost should make those considering six- or eight-laned highways hesitate.

There are a few obvious limitations of the dual-type

highway. First, the three-lane dual type should not be used around sharp corners, because it would encourage passing where the vision is obscured. Second, the three- or four-lane dual type is inefficient where an unbalanced flow may be desired. Third, in swampy ground the cement might require expensive filling, and there is no reason why the principle of a differentiation of smoothness and color cannot be developed in other materials. Fourth, the joints of the dual type might prove an additional maintenance problem, although past experience has not indicated this to be the case.

Some of the dual-type highways outside of Massachusetts have not been a success for some of the following reasons. In some instances the center lane was only 4 or 5 ft. wide, obviously not wide enough for use; in others the outside lanes were only a few feet from the ditch and motorists were afraid to use them. In still others, no parking facilities were provided, and parking on the outside lanes developed a series of "bottle necks." In some cases the cement was too smooth to prevent slipping and in wet weather motorists ran with one wheel on the macadam. All of these difficulties, however, were matters of faulty design and could easily have been avoided during construction at little or no additional cost.

The principle that traffic will follow the lines of least resistance and travel on the pavement with the most attractive surface has led us to the solution of one very difficult problem. This solution is in itself an example of another very important principle—that, wherever possible, control and enforcement should be built into highways. Construction enforcement is much more effective than personal enforcement, and far less costly in the long run. It is my belief that the dual type of highway will be used to an increasing extent and that, more and more, control and enforcement will be built into our highways.

Grade Separation

Another type of control which can be built into the highway system is that of grade separation. Commercial traffic, carrying many people and large amounts of merchandise, feels delay more than does the passenger-car traffic. Given roads of sufficient width, it is apparent that the greatest delay must occur at intersections. The capacity at the average intersection can be only one-half of the capacity of the two highways, for only one highway can flow at a time. Whenever commercial vehicles wait there is a heavy economic loss.

The only way to eliminate all delay and to extend the capacity of our highway system is to provide grade separation. At present there are many intersections where a delay occurs, which, if capitalized, would be sufficient within a few years to pay for a grade separation. Reducing delays cuts down the apparent distance between communities, thus enhancing their value and again justifying the cost of grade separation. The large number of grade separations in the park system of Westchester County, New York, is an excellent example of what can be done in this direction. If there are any local characteristics which would assist in making a grade separation, such as a difference in grade caused by a hill or a bridge over a railroad or river, advantage should be taken of them instead of installing rotary traffic or traffic-control signals.

Sometimes, however, the character of the intersection, due to the high cost of the land, large existing buildings, low, swampy land, or restrictions, such as rivers, lakes or railroad tracks, will make it difficult and uneconomical to build grade separations. These same difficulties will usually make it hard to install rotary traffic with a sufficiently large rotor to make it worth while. In such instances, and where the traffic volume is heavy, it becomes necessary to install traffic-control signals. The Department of Public Works of Massachusetts has gone into the study of traffic signals very thoroughly, not only for its own signals, but also because its written approval is required by law for all city and town installations.

Change from Dual Type to All Concrete
To Discourage Passing on Curve, Marlboro, Mass.

Traffic signals on the open highway are usually of the isolated type, the important intersections being too far apart for the efficient installation of progressive systems. The comparatively recent development of the traffic-actuated signal has provided a mechanism which appears to suit the needs of highway intersections. By a series of delay studies still being carried on, the actuated signal was found to cause much less unnecessary delay, and it is at present being used exclusively by the Department of Public Works even though its initial cost is materially higher than that of the ordinary fixed-cycle signal. The eventual cost, including delays involved, may be much less.

The details of the operation of these signals are already widely known. Their only purpose is to cut down delay costs to commercial and other vehicles and to reduce accidents. At the present time people do not realize the large costs involved in delay to vehicular traffic, which may be reduced by the proper use of signals. The code established by Massachusetts should do much to prevent the unnecessary installation of traffic-control signals, and to improve the quality of operation where they are necessary.

Special Provision for Commercial Vehicles

What provisions are cities and towns making, and what provisions should they make for commercial traffic? Unfortunately, not much has been done or is being done. The most outstanding improvements have been for passenger-car traffic, or at best for all traffic generally. Cities should provide commercial routes just as they are providing beautiful parkways for pleasure cars. The

volume of traffic may not be so heavy in numbers, but it certainly is important from the viewpoint of bulk of merchandise or number of persons carried by each unit.

The design of commercial structures should be improved so as to provide terminals for buses and loading bays for trucks. The economy of good terminals for

"LAMB CHOP" GRASS PLOT TO PREVENT CORNER CUTTING
In Throat of an Intersection, Brighton, Mass.

buses is proving itself everywhere today, and the loading of trucks over the sidewalk causes great delay, hazard, and friction to both motorists and pedestrians.

Provision for the loading of buses should also be made in the streets themselves. Wherever there is sufficient room, loading platforms should be built to be used by street cars and buses, and existing off-street trolley stations should also be used by buses. Every attempt should be made to prevent loading and unloading in the street. If bus stops are to be made at every corner, loading zones should be provided and parking prohibited, so that the buses can draw up to the curb.

The problem of unloading the truck, particularly the heavy truck, is a difficult one. In downtown streets, loading zones should be provided where any appreciable amount of loading exists. Unless this is done, double-line parking will result, a condition which, for hazard and delay to traffic, has few equals. Restrictions should be placed upon backing to the curb; one interesting development of the trucking industry has been dump trucks which unload from the side. To permit trucks to back to the curb is to reduce the capacity of the street, and to create a serious hazard due to obstruction and decreased visibility.

OPERATION ON THE HIGHWAY

The operators of commercial vehicles can do much to improve driving conditions; by setting a good example they can influence thousands of motorists. They should keep to the right in order to permit passing and should obey all existing traffic regulations. If drivers do not consider the regulations fair, they should apply pressure through their organizations to change them.

A commercial operator should be careful in the case of a breakdown to move his vehicle as far to the right of the highway as possible. A huge truck or van with a flat tire parked in the middle of the right-hand lane has caused many accidents. Bus operators should be careful to pull out of the way when they load or unload on the highway. A large bus stopped at an intersection restricts traffic and reduces visibility at the intersection.

ATTITUDE OF OWNERS AND DRIVERS

In the majority of cases the attitude of commercial vehicle owners and operators has not tended to promote safety and pleasantness on the highway. Owners are out to obtain the greatest return for their money, and if it is at the expense of the public, it is of no concern to them. Business interests should be called upon to help in bettering such conditions for they are in an advantageous position to do so.

As to the viewpoint of the commercial operators themselves, it is a rather difficult one. The continual grind is strictly business and there are just enough inefficient passenger-car drivers to keep them constantly irritated. The result is that they bluff their way through, taking advantage of their weight and skill. The police hesitate to prosecute them because driving is their bread and butter.

As vast sums are being involved in transporting persons and merchandise over our streets and highways, inefficiencies in design and control result in large economic losses. There is no reason why we should continue to guess when

GRADE SEPARATION, SUDBURY, MASS.
Ample Clearance Between Stone Parapets and Edge of Pavement

it is comparatively easy to gather the facts and to work out highway design and control on an engineering basis. The growing increase in accidents and delays has served to stimulate studies of vehicular traffic, and I anticipate that engineering solutions of traffic problems will prove of great benefit to highway traffic in general, and to commercial traffic in particular.

Measuring Base Line with Duplex Bar in 1900
Now Replaced by Invar Tapes

Modernizing Triangulation Practice

Improved Instruments and Equipment Developed by Geological Survey

By William Bowie
Member American Society of Civil Engineers
Chief of Division of Geodesy, U.S. Coast and Geodetic Survey

What was formerly the tedious work of making triangulation observations has been greatly lightened by the use of scientifically designed and smaller models of theodolites. Thirty years ago all observations were made during daylight hours, whereas now, by use of electric signal lamps, lines as long as 152 miles have been more accurately observed at night. In flat country, steel towers up to 150 ft. in height can now be erected in a day for both signal or instrument support. Major Bowie here describes the rapid advances which have been made by the Coast and Geodetic Survey in extending the triangulation net of the United States.

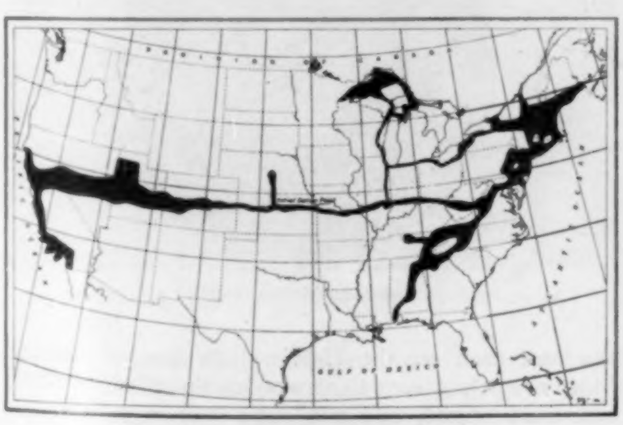
Speeding up of the field work of the U.S. Coast and Geodetic Survey during the past few decades has resulted from the greater dependence upon triangulation data in surveying, map making, and in other engineering work. Prior to 1902, the greatest number of triangulation stations established in a surveying season by a single party was 15. The chief of this party was A. T. Mosman, and the work was done in Kansas along the 98th meridian. The length of the season was three and one-half months. In 1902, a new field procedure was put into effect, which resulted in a double observing party establishing 75 first-order stations along the 98th meridian in seven and one-third months. The length of the arc involved in this work was 440 miles.

During the interval between July 31, 1929, and January 31, 1930, a double observing party, working on an arc of triangulation extending along the Mississippi River from Cairo, Ill., to New Orleans, La., established 180 first-order stations. The distance along the axis of this arc was approximately 615 miles.

In 1928 a triangulation party with two observers operated from Nevada, Iowa, along the 93rd meridian to the vicinity of Little Rock, Ark. The distance along the axis of this arc was about 590 miles, and 96 stations were occupied. The first observations began on June 14, 1928, and the last were made on September 28, 1928. The arc from Iowa to Arkansas ran over a region that was ideal for triangulation since the area was gently rolling and there were excellent highways along most of the routes.

Triangulation along the Mississippi River was considered very difficult because the country is very flat and the trees high and, necessarily, the stations had to be placed rather close together. The party was divided into two units, since there were stations on each side of the river for most of the arc.

A very great increase in the rapidity with which triangulation is executed has resulted from the following improvements: the use of electric signal lamps to furnish the lights on which the observer makes his pointings; employing a group of trained men to attend to the signal



First-Order Triangulation in 1900
7,000 Miles of Arc

Triangulation Net in 1930
30,000 Miles of Arc

lamps; the use of automobile trucks for transporting the observing and building units; better highways; the Bilby steel tower; and simpler and smaller theodolites.

EARLY USE OF SIGNAL LIGHTS

Prior to 1902, observations in the United States for first-order triangulation were made almost exclusively during daylight hours. The objects pointed upon were poles or targets, or the sunlight reflected from the mirror of a heliotrope. Observations on such objects are frequently interrupted because of a slight haze, which makes it impossible to observe on poles or targets where the lines are more than a few miles in length or where cloudy weather prevents the use of the heliotrope. These conditions have been overcome by the use of the electric signal lamp.

Oil-burning lamps with reflectors were used on the work for a few months in 1902 and then, for the rest of the season, acetylene bicycle lamps with condensing lenses. These acetylene lamps were quite satisfactory as the lines of the triangulation were, in general, less than 25 miles long. A few years later, when the acetylene automobile headlight came into general use, it was employed as a signal light. This lamp was used until about 1914, when it was found that the electric automobile headlight with a special contracted-filament bulb would give better results. Improvement in the electric lamp has been made from time to time, and it has now reached a high degree of perfection. Ordinary dry cells supply the electric current; for short line sights two or three cells will furnish a light that is quite brilliant. When, in 1920, two of these electric lamps were used at a station in Arizona, the light from them was observed at another station 152 miles away. It was visible to the naked eye and seemed to be about as bright as the Pole Star.

Heavy Wooden

Light Wooden

Bilby Steel

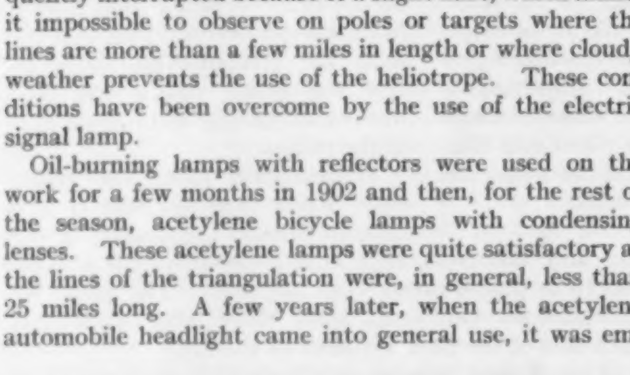
EVOLUTION OF THE TOWER

FIRST USE OF AUTOMOBILES

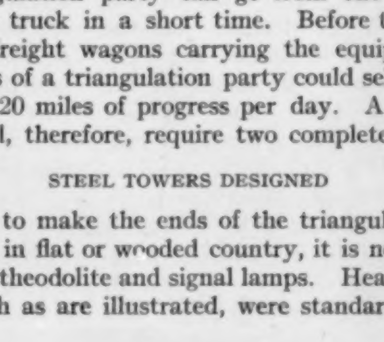
Before 1912, no automobiles or automobile trucks had been used by the Coast and Geodetic Survey in its surveying work. During that year a truck was used for the first time in the measurement of bases for the triangulation along the 49th parallel. It proved to be so satisfactory that steps were taken to have trucks employed with other geodetic parties. The users of trucks were somewhat handicapped at first because of the scarcity of hard-surfaced highways, but now the highway problem is being solved so that the engineer in charge of a geodetic party seldom has to go far to reach a good highway on which to move from one station to another. As the lengths of the triangulation lines vary from 5 to 40 miles, it can readily be seen that the observing and other units of a triangulation party can go from one station to another by truck in a short time. Before trucks were used, the freight wagons carrying the equipment and instruments of a triangulation party could seldom make more than 20 miles of progress per day. A trip of 40 miles would, therefore, require two complete days.

STEEL TOWERS DESIGNED

In order to make the ends of the triangulation lines intervisible in flat or wooded country, it is necessary to elevate the theodolite and signal lamps. Heavy wooden towers, such as are illustrated, were standard 40 years ago and used on the Holton base line in Indiana. More recently a very light wooden tower, with both the theodolite tripod, and the outer four-legged structure holding the observer's platform and the light stand, was developed with slightly curved legs to add stiffness.



MEADE'S RANCH, INITIAL STATION FOR NORTH AMERICA



STANDARD METAL TABLET

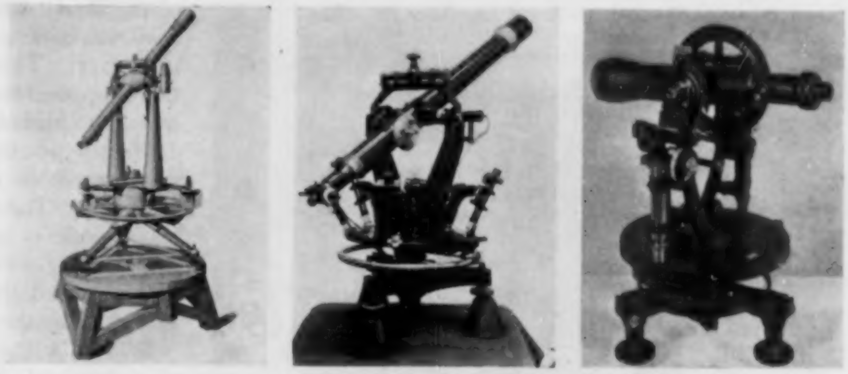
While believed to be the best type of wooden tower ever used, its height has been limited to 75 ft. to the observer's platform, with the outer structure extending 20 ft. higher.

A steel tower was designed in 1927, by Jasper S. Bilby, Chief Signalman of the U.S. Coast and Geodetic Survey, that has become the standard triangulation tower of the bureau. The regular tower has been used to heights of 129 ft. to the top of the inner structure, and 139 ft. to the top of the outer structure. Should a greater height be needed, as was the case on the Mississippi River triangulation, 10-ft. supplemental sections can be added to the tops of the inner and outer tripods. Normally, the height of the tower at a triangulation station will be not more than 90 ft. This height is exceeded only where the country is flat and the timber high.

In general, where 12 towers are used on an arc of triangulation, 8 are standing and in use by the observing party; two are in process of erection ahead of the observer; two are being dismounted at the rear or are on automobile trucks proceeding to the next two stations ahead. It has been found to be slightly more economical to use two observing parties on an arc of triangulation, one at each side of the arc. The same group of lightkeepers can be used for both observers. The beam of light from an electric signal lamp is so concentrated that there is no chance of the pointings of one observer being influenced by the light directed toward the other observer.

Where the steel towers are more than 103 ft. in height, it is necessary to have six men in the building unit which erects them. For towers of 103 ft. or less, five men can easily take care of this work. Three or four men are needed for taking the tower down, the larger number being used for towers that are more than 103 ft. in height.

In erecting the observation towers, it is a delicate job to plumb the tops of the inner and outer structures and to locate the theodolite on the observation platform and the signal lamp at the top directly over the station mark on the ground. An instrument for this purpose, called the vertical collimator, has been devised by the Coast and Geodetic Survey. It is set up without a tripod over the center of the concrete station mark on the ground. The observer must get down on his hands and knees in order to look into the horizontal telescope and accurately plumb the theodolite and the signal lamp above. The instrument used on the Mississippi River arc is illustrated.



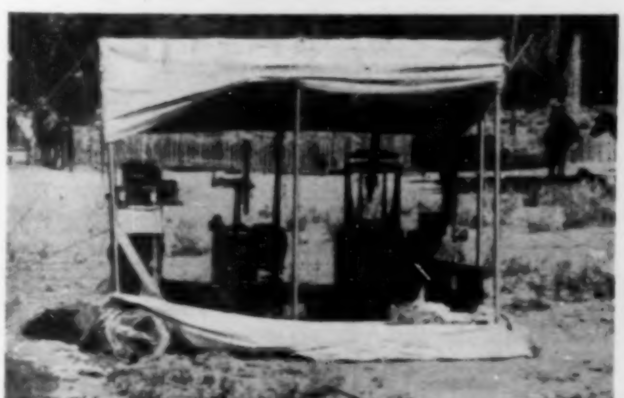
30-in.—1844 to 1873 12-in.—1900 to 1923 9-in.—Parkhurst—32 lb.

EVOLUTION OF THE THEODOLITE

Since the beginning of the 1927 season, about 900 stations have had towers erected over them, all firmly anchored to the ground. In only three cases have towers collapsed, two in Iowa and the other in Pennsylvania, all failures being caused by very strong winds. Some of the towers have been used at more than 38 stations, and the reports indicate that they are now in as perfect a condition as they were when purchased two or three years ago. Steel towers can be erected very much more rapidly and at a lower cost than the wooden towers which were in general use prior to the World War.

BASE LINES

Prior to 1901, base lines for first-order triangulation were measured with duplex bars supported on tripods, a slow, tedious, and expensive method, as may be seen from the number of men surrounding that equipment in the illustration, which was taken in 1900 at Alice, Texas. A 50-meter standardized invar tape has long since replaced the duplex bar. Base lines are thus measured at less than one-quarter of the former cost. The tape, during base-line measurements, is placed under a con-



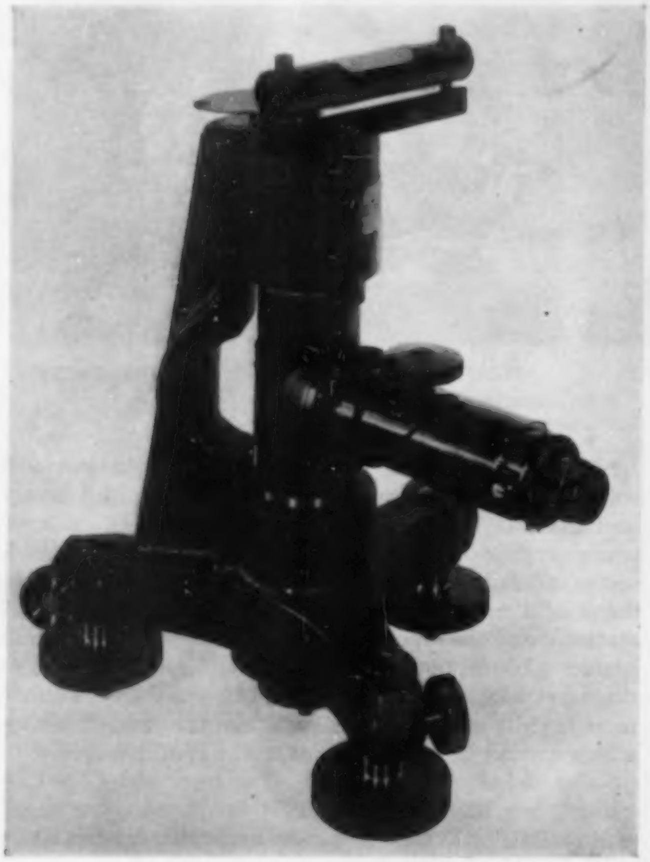
LATITUDE AND LONGITUDE OBSERVATION STATION IN 1914

LATITUDE AND LONGITUDE BY RADIO AND ASTRONOMICAL TRANSIT

stant tension and the ends are transferred to metal strips fastened to posts set rigidly into the ground.

IMPROVEMENTS IN STANDARD THEODOLITE

For about 30 years, the standard theodolite of the Coast and Geodetic Survey was the 12-in. horizontal circle type designed and constructed by the Coast and Geodetic Survey. The instrument was read for degrees and minutes by means of an index microscope and for the seconds by three micrometer microscopes. It was an excellent instrument and gave remarkable results, its only drawbacks being that it was slow in operation and rather cumbersome to pack to the top of a mountain peak or to raise to the top of a tall tower.



VERTICAL COLLIMATOR FOR PLUMBING OBSERVATION TOWERS

Today, the standard instrument is a theodolite with a 9-in. horizontal circle, which is read by only two micrometer microscopes. Readings of the microscopes of this instrument and of the older instruments are to single seconds. The new instrument was designed by D. L. Parkhurst, Chief of the Instrument Division of the Coast and Geodetic Survey, and has several novel features which make for rapidity of observation and excellent results. The vertical axis of the alidade has two cones, one at the lower end, and one near the top, whose apexes meet in a common point. This arrangement has the advantage that the axes do not bind when there are great changes in the temperature of the instrument.

The Parkhurst theodolite is fitted with a convenient device for lighting the cross wires of the telescope and microscope and for use in reading the micrometer heads, or drums. The vertical axis is perforated, and from its lower end wires lead to the batteries which supply the electricity, placed on the ground under the instrument stand. Dry cells are used to illuminate the theodolite. The micrometer drums are made of milk-white glass and are illuminated from the inside by small electric bulbs. By touching a button, the graduations on the outside of the drum can be readily seen, and the observer thus does not have to use a pocket flashlight as was formerly necessary. This instrument works quite freely, and there is no tendency to deflect its base in azimuth when the alidade is turned from one object to another.

Highly accurate results are obtained with modern instruments as is indicated by the closing errors of the triangles. The average closing error for a whole season's work is usually slightly less than 1 sec. of arc. The closing error is, of course, the difference between 180 deg. and the sum of the three observed angles diminished by the spherical excess of the triangle.

While the Parkhurst 9-in. theodolite is now considered the standard instrument for first-order triangulation by the Coast and Geodetic Survey, excellent results have been obtained with the 9-in. theodolite made by commercial firms in this and other countries. However, it is reasonably certain that from now on any additional instruments purchased by the Coast and Geodetic Survey will be of the Parkhurst type. Whenever other instruments prove superior, of course, future purchases would be of the newer and better type.

RAPIDITY OF OBSERVATIONS

The first Parkhurst 9-in. theodolite made by the bureau was used by H. W. Hemple, Assoc. M. Am. Soc. C.E., chief of the triangulation party which operated on the Mississippi River arc. He reported that he frequently finished the principal observations at a station within an hour, and his shortest time for this was 55 minutes. Observations at a first-order station normally consist of the determination of the directions of five lines radiating from the station occupied by the observer. One of the lines is chosen as the initial, and after the pointing has been made on the light at the opposite end of this one, and the micrometer microscopes have been read, the telescope is pointed in turn to the lights at the opposite ends of the other four lines. In each case the two micrometer microscopes, which are placed 180 deg. apart, are read.

Observations are first made clockwise from the initial line to the last one of the five; then the telescope is reversed and observations are made on these five lines in the reverse order. If there were no eccentricities of centers of the instrument, if the graduations of the circle were perfect, if the instrument were in perfect adjustment, and if the observations were perfect, the directions or angles would be the same for the reversed readings as for the direct ones. These ideal conditions, however, cannot be obtained. The mean of the forward and backward readings constitutes one measure of the directions.

After the first set of observations is made, the circle is changed in azimuth a certain number of degrees and the observations are repeated in what is called the second position. In this position observations are also made in a clockwise and counter-clockwise direction. The circle then is changed again and so on for each of 16 po-

sitions. It will thus be seen that for a station with the normal number of radiating lines—five—there will be 160 pointings of the telescope on the signal lamps, with two readings of each micrometer for every pointing. Thus, there will be four micrometer readings for each pointing, or 640 for the total number of observations. John Bowie, Jr., in charge of the subparty on the Mississippi River triangulation, using a Hildebrandt 9-in. direction theodolite, was able to finish observations at each of several stations in one hour.

There are several important phases of triangulation in addition to the observing. The towers must be placed and erected; the lamps must be attended by trained lightkeepers; the reconnaissance must provide stations in readily accessible places and lines of such length that the lights will be visible during average weather conditions. The time of actually making the observations is small as compared with that required for transportation, computation, and the ordinary management of the observing party. These conditions are just the reverse of those prevailing 30 years ago.

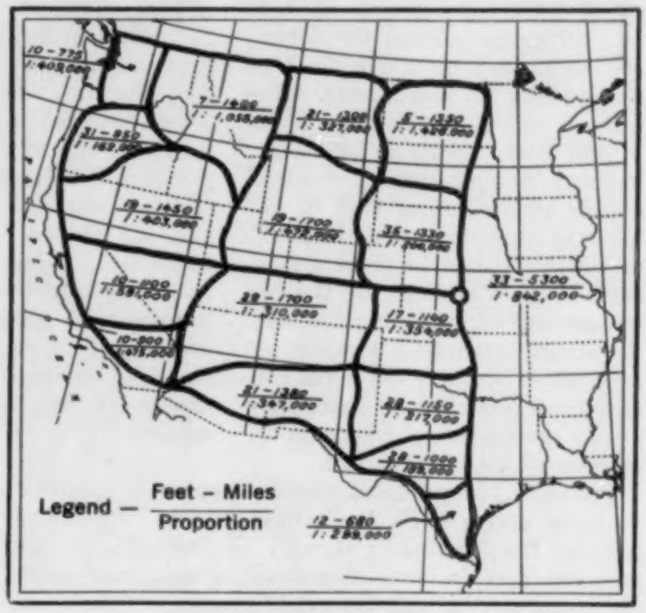
A report has recently been made to the office of the Coast and Geodetic Survey by Paul A. Smith, the engineer in charge of a triangulation party working on the Atlanta-Shreveport arc. On May 14, 1930, he made the observations at the station called Marion, in Alabama, in 40 min. He stated that there were no rejections of any of the measurements, and the largest deviation of a single measurement from the mean was only 2.57 sec., while the average deviation was only 1.20 sec. The observer is permitted to accept any measurement which has deviated not more than 4.00 sec. from the mean of the 16 measures of a direction. The average closing error in Smith's work is slightly less than 1.00 sec.

The initial station for all of the triangulation nets of North America is known as Meade's Ranch, located in central Kansas. North America is unique in that all of its triangulation is computed from a single point and all of it is on the same spheroid of reference. The illustration shows the new concrete mark with metal tablet set in the ground in 1922, replacing the original mark set in 1891. Such an important station should be preserved by the erection of an imposing monument.

All triangulation stations are marked by blocks of concrete or outcropping rock into which is set an inscribed metal tablet. In addition to the station mark, a reference mark is placed nearby, and at a distance of a quarter of a mile an azimuth mark is set. The local engineer can obtain his true bearing by occupying the station and sighting on the azimuth mark. Since these metal tablets were inaugurated 21 years ago, destruction of triangulation stations has very much decreased.

Prior to 1914, latitude and longitude observations required the two instruments pictured in the observation tent, with telegraphic connection to the nearest station to obtain the difference in time. Two observers were required, and the location at which longitude stations could be studied was necessarily limited. Today, with the radio connection to the U.S. Naval Observatory to obtain the difference in time, or longitude, between the observatory and the field station, and with the broken telescope astronomical transit, these observations can be quickly made wherever an instrument can be carried.

An adjustment of the 13,000 miles of arcs of first-order triangulation in the western half of the United States has been completed. The diagram shows the closing errors of several circuits in feet, the perimeter of the circuit in miles and the proportion of closing error to perimeter. It will be noted that only two of the sections have closing errors greater than 1:200,000 and that the average error is 1:435,000. The geographic positions of the triangulation stations resulting from this adjustment



Errors of Closure in the Western Net

are expected to be fixed for all time, unless shifted by an earthquake. The adjustment of the net of the eastern half of the United States is now in progress.

TRIANGULATION IMPORTANT TO ENGINEERS

The opinion of engineers regarding triangulation has changed materially in the past decade or so. Formerly they felt that triangulation was a scientific operation which could be mastered only after a great length of time. This kept them from using it to any marked extent in their surveying, mapping, and other engineering work. Today, with modern instruments, steel towers, easy means of transportation, and electric signal lamps, an engineer can cover the area in which he is to operate at a much more rapid rate and at a much lower unit cost than was formerly necessary for the making of his horizontal control surveys. Triangulation is indispensable in tunnel work and in laying out positions for the abutments and piers of bridges. It is, of course, essential for accurate horizontal control of topographical and other forms of surveying and mapping, and is most valuable in determining the geographic positions or the plane coordinates of county and State boundary monuments and in locating the corners of private property. No longer is triangulation a mystery. The instruments used are well known to civil engineering students and to many practicing engineers, and the methods of using them and of making computations are given in detail in the manuals of the Coast and Geodetic Survey, and in up-to-date textbooks on higher surveying.

A Successful Highway Toll-Bridge Project

Prize Student Paper Explains Erection Methods on Alton–St. Louis Bridges

By Marshall Pitney
Junior, American Society of Civil Engineers

One of the fine things accomplished by the Society's Local Sections is the encouragement of effort among Student Chapters. This paper is a result. Many contributions were submitted at the University of Colorado last spring, of which Mr. Pitney's was adjudged the best and was awarded first prize by the Colorado Section—payment of his obligations as Junior of the Society for a year. Incidentally this account well illustrates what a wide-awake young man can learn of practical engineering by close application to work on some construction project during his summer vacations.

In the present era of toll-bridge promotion, the Alton–St. Louis project, over the Mississippi and Missouri rivers, takes rank as one of the largest in the Middle-East. Being an inter-State highway development, it required double authorization, that is, the board of supervisors of both Illinois and Missouri had to grant a franchise to build and operate the two bridges and the adjoining roadway. Regulatory control, however, is maintained by fixing the initial rate of toll and providing for a reduction after a certain rate of return on the investment has been reached.

Primarily, this project is intended to provide improved vehicular access to St. Louis from Illinois. Instead of crossing the Mississippi directly at St. Louis, it approaches from the north, thus avoiding interference with numerous existing railroad grade crossings. The route crosses the Mississippi River at Alton on a structure 3,700 ft. long, beyond which it proceeds along a roadway 3.8 miles in length across the peninsula between the Mississippi and Missouri Rivers, a few miles above their confluence. Thence the Missouri River crossing, 2,100 ft. long, is followed by a roadway 1.5 miles in extent which connects with existing Missouri State roads.

On the north, or Illinois end, the approach to the Mississippi River span is by a series of through-girder and deck-truss spans, 13 in number, followed by 7 through-truss spans, of which 6 are 284 ft. long, while the largest, 445 ft., spans the channel section of the river. The Missouri River structure is considerably shorter, and consists of 200 ft. of steel girders on the north end, followed by 4 through-truss bridges, each 445 ft. in length.

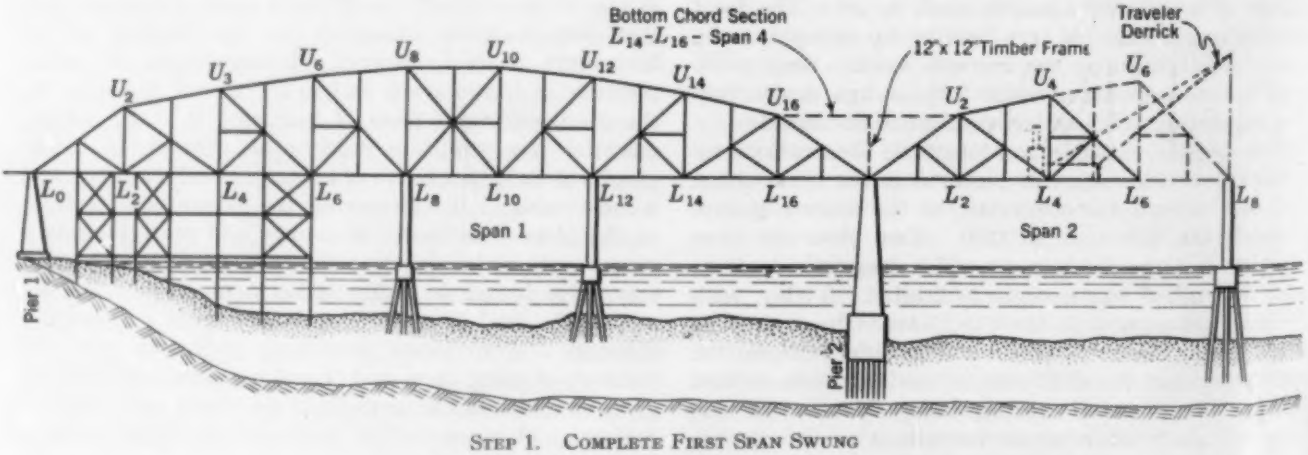
End Panels Floated into Place

Details for the substructure of the Mississippi River bridge were not unusual. Piers were founded on piles driven in an open caisson and surmounted by a timber crib 25 ft. in depth. In cross-section, the concrete masonry was in the form of a dumb-bell and was constructed from a floating concrete rig using adjustable steel forms 8 ft. in height.

In building the superstructure, steel erection was carried on simultaneously from both ends of the bridge. One feature of special interest was the erection of 75 ft. of the first span. This was built on two barges at the loading dock and pushed half a mile upstream, where it was placed in position over the pier and the first falsework bent, as shown in the accompanying photograph. The two barges were then filled with water and allowed to sink, permitting the steel truss to come down in place on the pier and the falsework. The rest of the steel was loaded on the barges, which were pushed up the river and tied under the point of erection. The traveler derrick shown resting on the floor beams of the truss was used for the erection of the remaining steel.

Revisions Required in Missouri Spans

For the structure over the Missouri, the piers were of the same design as on the Mississippi bridge but had a uniform height of 75 ft. above mean low water. In order to hasten the work, wood forms were used; because of the adjustment necessary for each succeeding lift, steel forms would have delayed the pouring of the concrete to a certain extent. Concrete was mixed



Step 1. Complete First Span Swung
Part L_0L_4 of Second Span Acting as Cantilever

at a central plant and hauled out on a tramway which was built on the outside of the adjacent Burlington Railroad bridge. To reduce the danger of the river cutting under the pier bases, 1,000 tons of riprap were deposited around the two piers directly in the channel of the river.

A study of the deep and shifting sand bottom of the Missouri River at this point, and the possibility of floods and ice, led the contractor to devise an interesting scheme of cantilever erection, illustrated in the accompanying diagrams, which reduced the falsework to a minimum. The steel spans were redesigned in the contractor's office to permit partial cantilever erection.

The decision to cantilever beyond panel point 8 necessitated important changes in the structure itself. These included a change from carbon to silicon steel for the members, U_6-L_8, U_8-L_8, U_8-L_{10}, and L_{12}-M_{13}. Both the size and the weight of the member U_6-L_8 were changed.

In addition to these revisions, stiffener angles were provided in the floor beams, L_0, L_8, L_{12}, and L_{18}, where jacks were used. Further, the top- and bottom-chord splices were arranged so that the former occurred at the right-hand end of the top-chord section and the latter to the right of the bottom-chord panel point.

MISSOURI RIVER BRIDGE
Traveler Completing Last Operation in Erection of Span 2

CANTILEVER ERECTION PROCEDURE

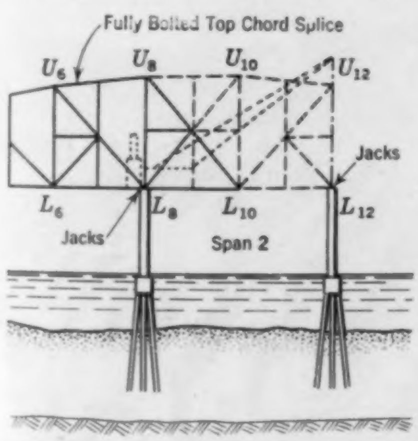
Sequence of erection procedure can be followed in steps 1, 2, and 3. For the first span it required timber and steel falsework under the first six panels and steel falsework under panel points L_8 and L_{12}. For spans 2, 3, and 4, a uniform plan was adopted, namely, the use of steel falsework under panel points L_8 and L_{12}, and a timber frame on piers 2, 3, and 4, supporting the center of the tie member between the top of the end posts of the adjacent spans. This tie, made up of the end bottom-chord section of span 4, held the rear end of the second span in cantilever position during erection out to panel point 8.

On the first span, after the erection and the riveting of the trusses from L_0 to L_8 with the exception of the splice of the top-chord at U_8, cantilever erection was used to L_{10}, followed by the erection of the steel falsework bent at point L_{12}, and the completion of the bridge to this point. In no case were the front trucks of the traveler allowed to pass beyond the riveted truss members. Jacks were used to raise both panel points L_8 and L_{12} several inches above the final grade so that necessary adjustments could be made when the span was ready to be swung.

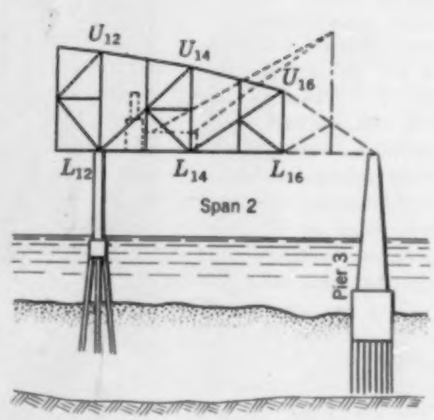
ALL THE SPANS ADJUSTED

At U_6 the top-chord splice was fully bolted until the erection had reached panel point L_{12}. The bolts were then removed, and the splice was left free to move during the cantilever erection beyond panel point L_{12}. Whenever this splice opened more than $^7/_8$ in., the jacks under panel point L_8 were lowered until the splice closed again. The last chord section of each span was placed on blocking with the floor beam at this point resting on jacks. As these jacks were raised, the span swung free of the falsework bents under points L_8 and L_{12}. These bents were then removed, and the end of the span was lowered to its final position.

The erection of spans 2, 3, and 4 followed the same procedure as that for the first span. Rockers were placed under panel points L_0 of each truss until that part of the truss between the pier and the steel bent at L_8 was completed. The rockers were then replaced by fixed shoes. This method of erection not only eliminated



STEP 2. SECOND SPAN
L_0L_8 Acting as Simple Span, with L_8L_{10} Acting as Cantilever

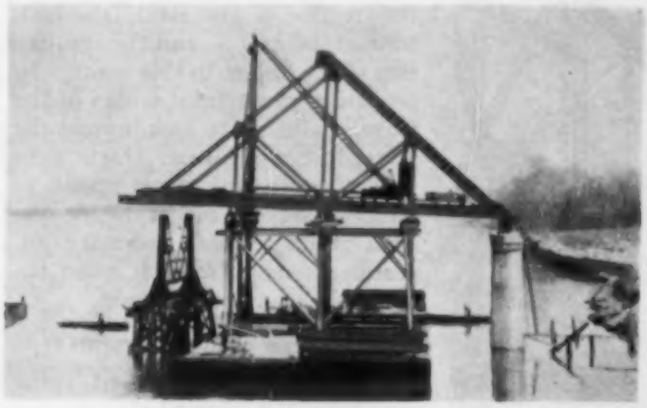


STEP 3. SECOND SPAN
$L_0L_8U_8$ Acting as Simple Span, L_8 L_{12} Acting as Anchor Arm, and $L_{12}L_{16}$ Acting as Cantilever

the hazard of having a large quantity of falsework in the river but materially speeded up the work. Conditions when the second span was almost completed are illustrated in the photograph.

RESPONSIBILITY FOR THE PROJECT

The substructure of the Mississippi bridge and the complete bridge over the Missouri River were built by



MISSISSIPPI RIVER BRIDGE
Erecting End Panels

the Kansas City Bridge Company, with C. W. Cubbage, Assoc. M. Am. Soc. C.E., as general superintendent of construction. The superstructure of the Mississippi Bridge was built by the Wisconsin Bridge and Iron Company, with Mr. O. Hanson as erection superintendent. The project was designed by Harrington, Howard, and Ash, Consulting Engineers, for whom C. D. Weller, M. Am. Soc. C.E., was the Resident Engineer.

By means of this private project, 57 railroad crossings were eliminated between Alton, Ill., and St. Louis, Mo., in a distance of 33 miles. In addition, the driving time by automobile has been shortened by 25 minutes. This bridge has been in successful operation since July 1928.

COST AND QUANTITY ANALYSIS

The cost of the entire project was nearly $2,500,000, divided as follows:

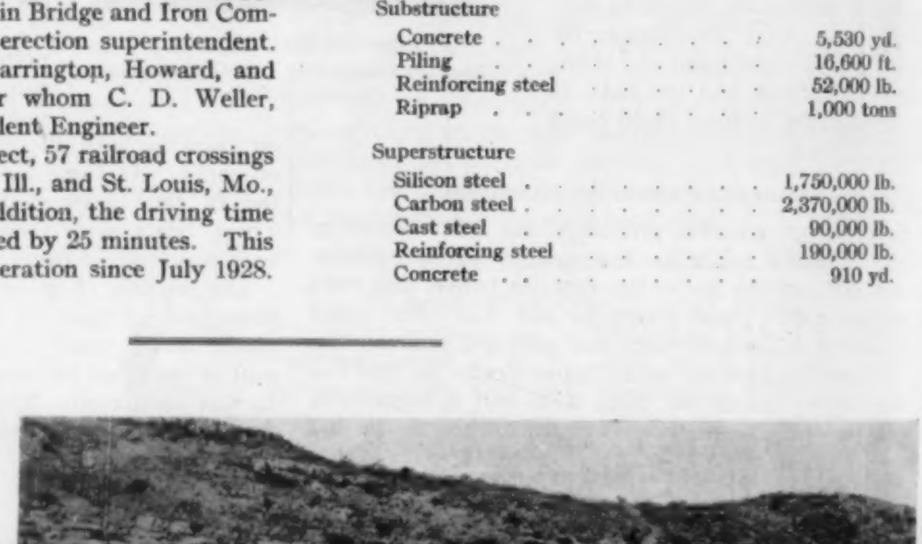
Mississippi Bridge:	
Substructure	$324,000
Superstructure	437,000
Missouri Bridge:	
Substructure	$217,000
Superstructure	326,000
Roadway	315,000
Rights of way, construction of 106-ft. road bridges and miscellaneous	800,000

The approximate quantity of material used on the two bridges was as follows:

Mississippi Bridge	
Substructure	
Concrete	9,510 yd.
Piling	31,400 ft.
Reinforcing steel	200,000 lb.
Riprap	2,000 tons
Superstructure	
Silicon steel	440,000 lb.
Carbon steel	5,370,000 lb.
Cast steel	110,000 lb.
Reinforcing steel	380,000 lb.
Concrete	1,910 yd.
Missouri Bridge	
Substructure	
Concrete	5,530 yd.
Piling	16,600 ft.
Reinforcing steel	52,000 lb.
Riprap	1,000 tons
Superstructure	
Silicon steel	1,750,000 lb.
Carbon steel	2,370,000 lb.
Cast steel	90,000 lb.
Reinforcing steel	190,000 lb.
Concrete	910 yd.

AN UNUSUAL DAM

An interesting picture of an old Spanish dam constructed near Aguascalientes, Mexico, has been submitted by Julian Hinds, M. Am. Soc. C.E. This structure, which is 70 ft. high, appears to be nothing more than a masonry wall supported by heavy buttresses. In this type of structure, the uplift pressure finds relief in the wide spaces between the buttresses. It is very likely that this dam will not satisfy all of our present-day requirement for stability, yet there it is, an overflow dam full to the top. Note the projecting stones over the overflow areas for the purpose of breaking up the velocity of the overflowing water.



Purifying Water for Domestic Use

Progress in Aeration, Chemical Treatment, and Filtration Methods

By Robert Spurr Weston

Member American Society of Civil Engineers

Weston and Sampson, Consulting Engineers, Boston

The description of an early method of treating water for human consumption is contained in a Sanskrit collection of medical lore, probably dating back to 2000 B.C., in which appears the instruction, "It is good to keep water in copper vessels, to expose it to sunlight, and filter through charcoal." For centuries it has been a practice in China and Egypt to put alum in water to clarify it. The modern treatment of water to remove pathogenic organisms began soon after Robert Koch proved the correctness of the germ theory of disease in 1875. There are now in operation probably more than 600 rapid sand filter plants. Mr. Weston's paper was read July 16, 1930, at Yale University, at the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education.

The methods of water treatment in most common use include storage, aeration, chemical treatment, filtration, and disinfection. Long storage, where practicable, is the most efficient of purification methods, as is evidenced by the quality of water from the depths of great lakes and large ponds. In the temperate zone, ponds, lakes, and artificial reservoirs, which are from 15 to 30 ft. and more in depth, stratify both in winter and in summer. The water overturns, or undergoes circulation as a result of convection currents that occur throughout its entire depth during short periods in spring and in autumn. These phenomena are due, of course, to changes in density, water being at its greatest density at 4 deg. cent. (39.2 deg. fahr.). During the stagnant period, the bottom water loses oxygen to meet the bio-chemical oxygen demand of the organic matter; carbon dioxide is produced; and, if the process goes far enough, iron is dissolved and nitrates and sulfates are robbed of their oxygen, sometimes with production of hydrogen sulfide.

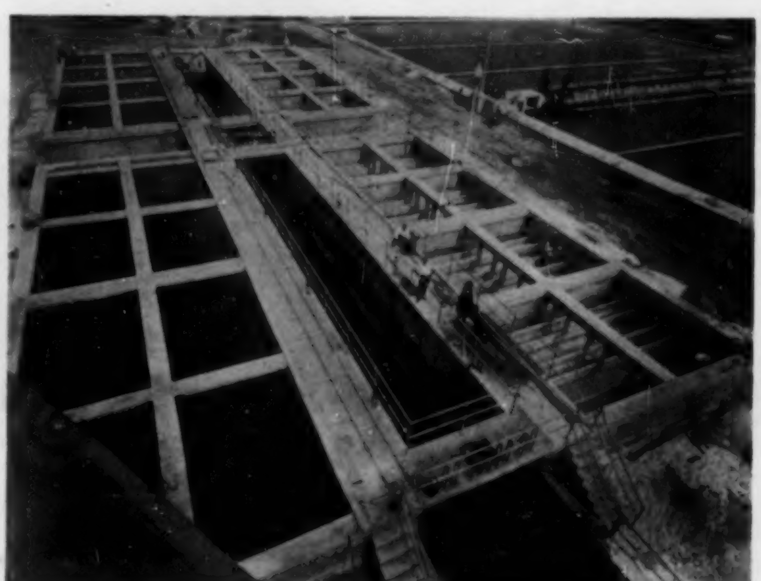
These stagnant bottom waters are frequently black and have a disagreeable odor, especially where the organic content is high or there is much soluble organic matter on the reservoir bottom.

Reoxidation of Turbid Waters

When these bottom waters are brought to the surface during the semi-annual overturns, they become reoxidized, the iron coagulates, and during the following quiescent period, it precipitates and clarifies the water. In this manner waters which are highly colored and turbid are bleached and clarified while the rapidly dying disease germs disappear. Microscopic organisms of various forms may grow in lakes and storage reservoirs, particularly in the smaller and shallower ones. They may produce an undesirable taste, odor, or color in the water. Such organisms rarely occur in objectionable numbers in reservoirs which store the run-off from the contributing catchment area for a period of seven months or more; that is, over one of the semi-annual circulation cycles, which consist of an overturn and a quiescent period between overturns. Sometimes organisms grow only on the surface. They may be avoided by drawing water from lower depths—from the transition zone which lies between the lower stagnant zone and the upper circulating one.

Microscopic organisms can be killed by the use of copper sulfate, chlorine, or in some cases by aeration. The use of copper sulfate for the purpose is almost universal. Doses consist of less than 8 lb. per million gallons; more than this amount may kill fish. Since the method of adding the copper sulfate determines its efficiency as well as its effect on fish life, care must be taken in its application. At Kansas City, chlorine was found more effective than copper sulfate.

Artificial aeration is used where the natural aeration at the surface of a reservoir is insufficient to prevent the production of odors by organisms and by objectionable gases in the water. It is accomplished in various ways, including sprays and nozzles, cascades and contact aerators. Sprays and nozzles are probably the most efficient type of aerators because they expose the most water to the most air at a reasonable cost. Some examples of this type of aerator are shown. Cascades may be used where sufficient head is available. The use



Rapid Sand Filters at West Palm Beach

of cascades in conjunction with architectural treatment may produce most pleasing effects. A more practical application of the method is illustrated by the aerator at Winchester, Ky.

Contact aerators are used in special cases—usually where something more than the mere washing out of objectionable odors and gases by air is required. Contact aerators prolong aeration and introduce some degree of oxidation by holding the matter to be oxidized until the action takes place. They are generally used to remove carbon dioxide and to oxidize the iron in certain ferruginous ground waters. Use is made of them at Pittsburgh, Pa., to retain the paraffin-like bodies derived from the oil wells and present in the Allegheny River water.


SACRAMENTO AERATION FIELD IN OPERATION

A contact aerator was tried experimentally at Chester, Pa., for removing the odor produced by polluting matter. In the so-called contact aerators, surface adsorption plays an important role and, in general, the greater the accumulation of matter on the aerator, up to the point of clogging, the better it works.

Chemical treatment is often employed to expedite natural purification. Among the chemicals commonly used are: (1) chlorine, as a sterilizing agent; (2) sulfate of alumina or lime with ferrous sulfate, as coagulants in sedimentation or filtration; and (3) lime or sodium sulfate where the water is hard. Chemicals are used in the majority of water purification plants. The use of chemicals as coagulants preceding filtration greatly reduces the load on the filters, usually with material savings in the cost of operation.

FILTRATION, SLOW AND RAPID

It is a principle of sanitary engineering to secure the best water available and purify it if necessary. Sometimes storage alone is sufficient to purify the water; sometimes storage and disinfection suffice. But in most cases filtration is required, not only to perfect the appearance—the criterion by which the public judges water—but also to place another strong line of defense between the consumer and pollution.

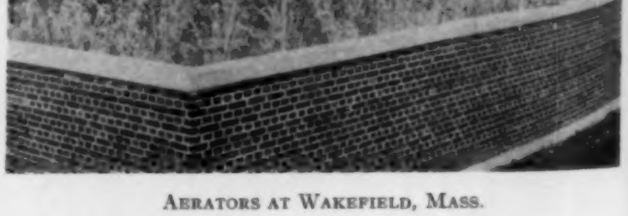
Filters are of two general kinds, slow and rapid or, as they are sometimes called, English and American. The former depends upon the natural film of bacterial jelly on the sand grains on the upper layers of the sand, and is cleaned by scraping; the latter depends upon coagulation and straining, and is washed, when dirty, by a backward flow of water through the filter. The rate of flow of water through a rapid filter may be from 20 to 30 times as fast as through a slow filter.

In spite of the flexibility and compactness of rapid filters and their more extensive use, slow filters still have their place and, where a high rate can be employed, may be even more economical than rapid filters. They are especially well adapted for the removal of iron or micro-organisms. For example, at Chester and Philadelphia, Pa., where water from the highly polluted Schuylkill River is purified, experience indicates that slow filters produce, from highly polluted sources, a water of much better taste and odor than does chemical treatment followed by filtration through rapid filters.

A modified slow filter has been devised by Henry W. Clark, of the Massachusetts State Department of Public Health. He loads the filter with ferric hydrate by treating the sand with ferric sulfate and an alkali, thereby precipitating the hydrate on the sand grains. This treatment greatly enhances the color-removing power of the filter, as the ferric hydrate and the color combine. After a certain time, the color-removing power of the filter is lessened, but it may be restored by treating the filter with sodium hydrate, which dissolves out the organic matter and leaves the ferric hydrate for further service.

COAGULATION METHODS IMPROVED

While the design and construction of rapid filters show a high degree of stability, many refinements in accessories and improvements in arrangements and methods of control have been made. There have also been decided advances in methods of chemical treatment, without which no rapid filter operates successfully.


AERATORS AT WAKEFIELD, MASS.

Properly treated waters are easily filtered, but the best of rapid filters fail with badly prepared influents. In the West, where turbid surface waters prevail, and rivers like the Missouri carry as high as 1 per cent of suspended solids, preliminary sedimentation is necessary. St. Louis first used raw river water, then raw river water after sedimentation, and now has added rapid filtration.

In the new plant at Howard Bend on the Missouri River, the settling silt is removed continuously from the preliminary subsiding basins by mechanical scrapers. The operation may be compared in magnitude with hydraulic dredging. It is estimated that at New Orleans, where conditions are by no means as bad as they are at St. Louis, Omaha, and Kansas City, enough silt is removed from a year's water supply to fill an ordinary city block to a depth of 6 ft. or more.

When Fuller made experiments at Louisville, Ky., in 1925, he found that sulfate of alumina was the best coagulant. Later a combination of lime and ferrous sulfate proved to be more efficient and economical for the same water. This combination is especially well adapted to hard waters which contain micro-organisms. It has recently been realized that a higher degree of softening in filtration may be accomplished by over-treatment with lime followed by recarbonization to remove the excess of hydrate and to prevent the deposit of carbonate on the filter sand. This treatment, in conjunction with the use of ferrous sulfate as a coagulant, is becoming more and more common.

In some cases sodium aluminate is useful, although it is ordinarily less economical than other coagulants. It is especially useful in maintaining a relatively low hydrogen-ion content (high pH value) in the water.

Aerator at Winchester, Ky.

Ferric chloride came into use as a coagulant about two years ago. Although its efficiency has been recognized for many years, its high cost prevented general use. Recently, however, it has been prepared by adding chlorine to ferrous sulfate, both of which are low priced chemicals. The resulting product, which has the advantage of combining a disinfecting action with coagulation, is known to the profession as "chlorinated copperas." Because of its high specific gravity as compared with aluminum hydrate, it is, for certain waters, the most efficient coagulant that can be found.

Aerator, Ashokan Headworks, Catskill Aqueduct

In the past, coagulating chemicals have usually been fed in solution, but the modern tendency is to feed them through dry feeders, the use of automatic proportionate dry feeders being generally favored. The requisites for good coagulation include: (1) proper reaction, (2) complete mixing, (3) flocculation, and (4) subsidence. The reaction depends largely upon the hydrogen ion concentration of the water, usually expressed as its pH value. In pure solutions, sulfate of alumina coagulates completely when the pH value is less than 6.0. In natural waters, coagulation is usually at its optimum at higher pH values.

Unfortunately, the pH value which is best for coagulation is often so far on the acid side that the treated water rapidly corrodes the distribution system. Such water may have to be corrected after filtration by the addition of lime or sodium carbonate. Hence, when certain soft waters are treated, it may be necessary first to add chemicals to promote coagulation, then to filter, and finally to add an alkali to prevent corrosion. In the case of certain colored waters, if enough alkali be added for both purposes before filtration, re-solution of the color will occur.

MIXING IMPORTANT

Complete mixing may be obtained by introducing the coagulant into the suction of the raw water pumps, or by the use of the hydraulic jump, diffusing outlets, baffled channels, or similar devices. Slow stirring in tanks by hydraulic or mechanical means is essential after the mixing. In theory, velocity during mixing should be high enough to limit subsidence, and low enough during the period of coagulation to promote flocculation.

Some waters are so clear that it is necessary to add suspended matter to accelerate flocculation, the particles serving as the nuclei of possible flocs. For this purpose clay is added, or suspended matter already pre-

cipitated in the coagulating basin is collected and reintroduced into circulation with the incoming raw water. The former practice is employed at Winnetka, Ill.; the latter at St. Louis, Mo., and at many softening plants.

After flocculation, the water must be stored for some time—generally from two to four hours—to indurate the flocs and to remove the excess of precipitate, as it is

A PRESSURE FILTER BUILT IN 1884
Formerly Used at Athol, Mass.

essential that the sand layer of the filter, through which the water will subsequently pass, must neither be overloaded with precipitate nor robbed of the amount of precipitate necessary to make it an efficient strainer.

DESIGN OF RAPID FILTERS IMPROVED

The original rapid filters were of the pressure type, but they have been superseded by the gravity type, which permits the operation of the filters to be watched and makes preliminary treatment more feasible. Gravity filters are usually rectangular in form, and the tendency is toward the use of large units—say, 5,000,000 gal. daily as compared with 1,000,000 gal. daily, the largest unit formerly in use.

Little improvement has been made in strainer systems. The trend is toward simple pipe systems with orifices, and dependence for distribution of wash water is more and more being placed upon gravel layers. A proprietary water distributor made of hollow tile, now on the market, may take the place of the coarser gravel, while Jenks has devised an arrangement of perforated tiles embedded in cemented gravel. Gore, at Walkerville, Ontario, Canada, successfully employs a layer of fine gravel with just enough portland cement to hold it in place (about 1 to 15), in order to prevent the shifting of the fine gravel just beneath the sand, that is, the upper of the several layers of gravel between the strainer proper and the sand layer.

Washing is usually accomplished by the use of currents of high velocity—usually of at least 24 vertical in. per min. as compared with less than 12 in. per min. formerly in use—either alone or in conjunction with currents of air. Herring and Hulbert, at Detroit, have increased these rates from 50 to 75 per cent and report excellent results. Their studies indicate that for efficient washing, the sand layer in the filter must be expanded 60 per cent. Naturally, because of the higher viscosity of water in winter, this degree of expansion requires lower rates of washing in that season.

The sand in different rapid filters may not be of the same size, although in any one filter the size of all of the grains of sand should be the same. In one of the large States a few years ago, it was noted that the filters which gave the best service had sand with an effective size between 0.38 and 0.45 mm. At present the tendency is toward the use of coarser sand and higher rates of filtration. A sand with an effective size as high as 0.55 mm. is being used successfully in several plants. Naturally, higher rates and coarser sands demand excellent pretreatment of the water; otherwise, imperfectly coagulated water will pass through the filters and deposits will occur in the distribution system.

USE OF CHLORINE INCREASES

The use of chlorine has meant great improvement in chemical treatment preceding rapid filtration. It is especially useful in the case of waters which are highly polluted or highly colored. Certain organic compounds, not readily precipitated with sulfate of alumina, react with chlorine so that, after it has been added, they are easily coagulated. At Exeter, N.H., it was found impossible to reduce the color of the water below 20. However, by the addition of only 0.6 part per million of chlorine (less than 5 lb. per million gallons) to the water before treatment with sulfate of alumina, the color could be reduced to 5, and with great saving in the cost of chemicals. While pre-chlorination is useful, even when chlorine is added to the sulfate of alumina, it is better to provide a period for the reaction between it and the water. A period of 30 min. has been provided at Chester, Pa., where pre-chlorination was recently introduced.

Certain waters which have bad odors and are difficult to treat have been greatly improved by pre-treatment with ammonia in conjunction with chlorine. It is probable that an amine is formed under these circumstances, the amine being a more efficient deodorant than is chlorine alone. Those waters which require large amounts of coagulant and which produce carbon dioxide by reaction with the natural carbonates in the water, are greatly benefited by being aerated before they are

SETTLING BASINS
Columbus, Ohio, Plant

filtered. This is done at Providence, R.I., Watertown, N.Y., Chester, Pa., Charleston, S.C., and elsewhere.

One of the difficulties encountered in filter beds is the tendency of sand grains to stick together and form lumps or mud balls. Because of their size it is almost impossible to remove them by washing alone. In some plants the beds are treated with caustic soda, which dissolves the cementing substance; in others, mechanical raking is used. Bayliss, at the Chicago experimental filter plant, has recently made use of a grid of perforated pipes placed in the upper sand layer, which has so far prevented the formation of these mud balls. In practice, Bayliss passes about one-fifth of the wash water through the surface distribution system. In the past, jets of air were employed for this purpose, but water is much better.

The presence in water of phenol-like bodies, notably those escaping from gas works and by-product coke ovens, is often the cause of highly objectionable tastes—particularly when the water is treated with chlorine. This treatment results in the formation of a so-called chloro-phenol taste. In some cases these tastes and odors may be removed by super-chlorination followed by de-chlorination by an antichlor, such as sulfur dioxide. In other cases treatment with potassium permanganate suffices, and several operators have found that odors can be completely removed by the passage of the treated and filtered water through activated carbon. At Chicago, plans are being made to treat all of the water in this way; and at Chester, Pa., the method was found effective for removing chloro-phenol odors as well as odors due to pollution by sewage and industrial wastes.

PROBLEMS OF WATER SOFTENING

Although the growing importance of water softening can only be mentioned here, its economic importance is gradually being realized, especially in cities where waters of high hardness are the only source of supply. Hard waters destroy soap, are bad for use in steam boilers, and are unsuitable for bleaching, dyeing, and

FILTER OPERATING TABLE
Baldwin Filtration Plant, Cleveland

other manufacturing processes. Fortunately, they may be easily softened, with great economic gains.

Of all the water supplies in the country which should be softened, it is probable that not over 10 per cent are effectively treated; and so slow is the public to appreciate the tremendous economic waste resulting annually from the use of hard water that Dr. Buswell, of the Illinois State Water Survey, is recommending the formation of a water-softening association for its education.

As most of the hardening constituents in water are held in solution by carbon dioxide gas, lime is the best and most economical chemical for removing them when they are present in quantity. The other materials mak-

COLUMBUS PURIFICATION PLANT
Filter Operating Room

ing up the mineral and acid hardness of water may be removed in part by treatment with sodium carbonate in conjunction with lime, or by passing through a zeolite.

Usually the choice of methods depends upon the degree of softening desired and the relative costs of salt for regenerating the zeolite, and of soda for the lime-soda process. Recent advances in water softening have made it possible to use a combination of the two processes, treating with lime to remove the carbonate hardness and with a zeolite to remove the sulfate hardness.

The greatest improvement in the use of the lime process has been over-treatment with lime, thus permitting the theoretical limit in reduction of hardness to be approached, namely, to less than 30 parts per million. Formerly, a hardness of 60 parts per million was all that could be obtained. The new modification is rather elaborate and requires recarbonization with carbon dioxide to remove the excess hydrate. In this process, as in coagulation in connection with rapid filters, great benefit has resulted from mixing the settled precipitates with the incoming water and by stirring the chemicals and water for a half hour or so to aid in the formation of precipitate.

In reviewing the progress of the art of water purification, it will be seen that we are depending more and more upon treatment and less and less upon the straining action of the sand in filters. Devices for the treatment of water are becoming increasingly efficient and liberal in size in order that filters may be operated without strain. The practice of providing ample storage for filtered water, in order to avoid the necessity for using varying rates of filtration, is also growing. In general, it may be stated that the art of water purification is now highly developed. Still further developments may be expected, however, because the limits of concentration of pollution have not yet been reached, and new problems will certainly require new adaptations of old solutions, as will old problems require new solutions.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of every-day experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Computing Moments in Continuous Beams

By L. C. Maugh
Junior American Society of Civil Engineers
Instructor in Civil Engineering, University of Michigan

Ordinarily, stresses set up by the usual concentrated loads are not difficult to calculate. With the multiplication of loads comes further complication and this is emphasized still more when the

Fig. 1. Influence Line for Negative Moment at Fixed End

loads are movable It is with the latter type of loading that this paper deals. As a means of simplification, uniform loading is chosen to replace the point loads and chosen in such a manner as to give equivalent results in terms of load effect. The means of accomplishing this and the ease of applying the results alike commend this convenient method.

UNIFORM LOADS FOR NEGATIVE MOMENTS

In point of fact, the maximum negative moment at the fixed end of a beam, as in Fig. 1, can be used as the basis for obtaining the equivalent uniform loads for negative moments in continuous beams. The maximum negative moment in a continuous beam will occur at the intermediate supports. Its value for a beam of three equal spans is given in the influence diagram, Fig. 2 (*a*). The influence line taken from Fig. 1 has been superimposed in dotted lines by reducing the ordinates by a constant ratio. Evidently, by the proper choice of scales, these independent lines exactly coincide for the first span of Fig. 2, and follow closely in the second span. For unequal spans, Fig. 3 (*a*), a similar condition obtains. Curves from Fig. 1 are also repeated, properly reduced, in Fig. 2 (*b*) and (*c*), and in Fig. 3 (*b*) and (*c*), for the negative moment at an intermediate point in each span, with the same results as for the moment at the support.

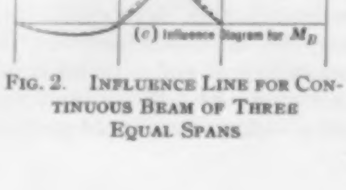


Fig. 2. Influence Line for Continuous Beam of Three Equal Spans

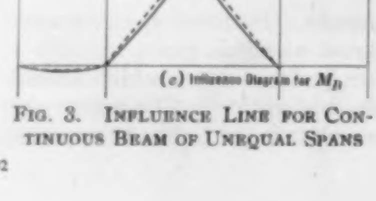


Fig. 3. Influence Line for Continuous Beam of Unequal Spans

An analysis of these curves calls attention to a number of important characteristics. In the first place, because of the similarity in shape of the influence diagrams, the same position of loads for maximum moment at the fixed end of the beam in Fig. 1 will also give the maximum negative moment in a continuous beam. The small discrepancy in the second span is not serious as it is somewhat compensating.

Since the positions of the concentrated loads are identical, and the ordinates of the influence lines are proportional, it follows that the uniform load which will produce, at the fixed end of the beam in Fig. 1, the same negative moment as is given by the concentrated loads, will do the same for the negative moments in a continuous beam. In other words, the equivalent uniform load for maximum moment at the fixed support of the

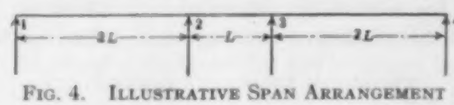


Fig. 4. Illustrative Span Arrangement

beam in Fig. 1, will give the maximum negative moment at any point in the continuous beam.

These relationships solve the problem as far as negative moments are concerned. By drawing the influence line of Fig. 1 to a large scale, the maximum value of the moment can be conveniently calculated for a given set of concentrated loads by two or three trial positions. If this moment is equated to $\frac{WL^2}{8}$, then the value of W, the required equivalent uniform load, can be easily determined.

UNIFORM LOADS FOR POSITIVE MOMENTS

The value of the positive moments at the mid-points of a three-span beam is given by the influence lines in Fig. 2 (*b*) and (*c*) for equal spans, and in Fig. 3 (*b*) and (*c*), for unequal spans. On the positive ordinates of Figs. 2 and 3, the influence lines for the moment at the corresponding point in a simple beam, are shown as dotted straight lines. If drawn to a certain scale, these practically coincide with the in-

fluence lines for the positive moments at a point in the first span, but have somewhat larger ordinates for a point in the second span. Evidently, the position of the forces for maximum positive moment is the same for both

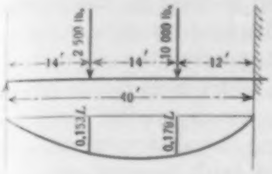


Fig. 5. Position of Loads for Maximum Negative Moment

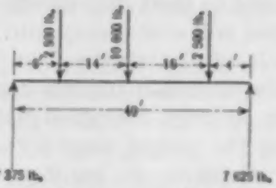


Fig. 6. Position of Loads for Maximum Positive Moment

continuous and simple beams, but the ordinates of the influence diagrams for the two beams do not maintain the same proportions as in the case of negative moments.

Since the value of the equivalent uniform load depends on the ratio of certain ordinates of the influence line to the area below the influence line, Table 1 has been arranged to give two of these relations for both continuous and simple beams. Thus, the ratios given in Cols. (5) and (10) represent the values of the equivalent uniform loads for a single concentrated load, and the ratios in Cols. (6) and (11) give the values of the uniform loads for three concentrated loads.

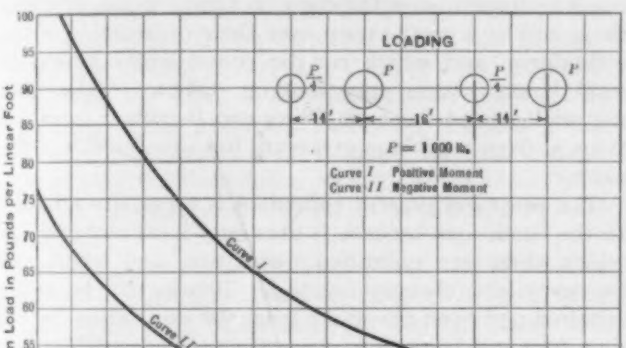


Fig. 7. Equivalent Uniform Loads for Moments in Continuous Beams

From Col. (12), the maximum difference, at the midpoint of the span, between the uniform loads for continuous and simple beams for three concentrated loads is 2.4 per cent. In the case of a single, concentrated load, the maximum difference is 13.8 per cent, but there is no advantage in using an equivalent uniform load for this case. As similar values can be obtained for other points in the span, it appears that a 5 per cent increase of the uniform load for a simple beam will give an adequate load for a continuous beam except for the case of a single, concentrated load. As the effect of alternate spans upon the positive moments in the continuous beam is very slight (see influence lines) the above uniform load for each span can be safely applied to those spans that must be loaded.

Example Showing Application

As a typical example, suppose a continuous reinforced concrete bridge of three 40-ft. spans is to be designed

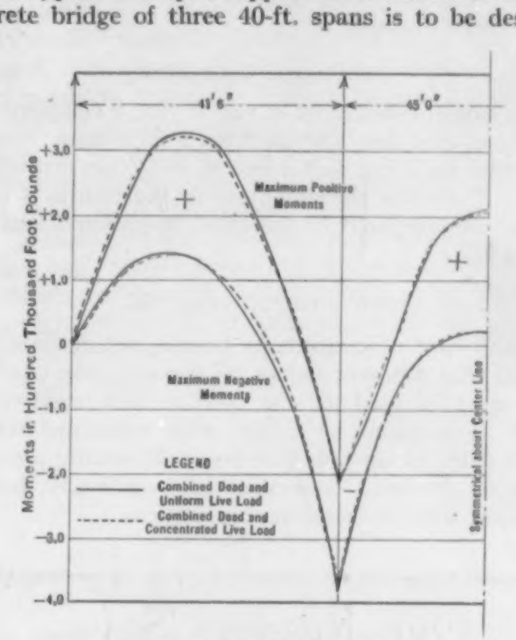


Fig. 8. Comparison of Results

for trucks with 16-ft. spacing and 14 ft. between axles. The concentrated loads are 10,000 lb. on each rear wheel, and 2,500 lb. on each front wheel. The position of the loads for maximum moment at the fixed end of the beam in Fig. 1 is shown by Fig. 5, together with the values of the ordinates of the influence line. The value of the moment as obtained from these ordinates is: $10{,}000 \times 0.179\,L + 2{,}500 \times 0.153\,L = 2{,}173\,L$. Therefore, $\frac{WL^2}{8} = 2{,}173\,L$, or $w = \frac{2{,}173 \times 8}{40} = 435$ lb. per lin. ft., which is the required equivalent uniform load for negative moments in the continuous beam.

The position of the loads for maximum moment at the center of a simple beam of 40-ft. span is shown in Fig. 6. The value of this moment is: $7{,}375 \times 20 - 2{,}500 \times 14 = 112{,}500$ ft-lb. The uniform load is, therefore,

Table I. Ratio of Ordinates to Areas of Influence Lines for Continuous and Simple Beams

	Continuous Beams					Simple Beams					
				Ratio					Ratio		
Diagram	Ordinate at Center	Sum of Ordinates at 0.2L, 0.5L, 0.8L	Area	$\frac{\text{Col. 2}}{\text{Col. 4}} \times L$	$\frac{\text{Col. 3}}{\text{Col. 4}} \times L$	Ordinates at Center	Sum of Ordinates at 0.2L, 0.5L 0.8L	Area	$\frac{\text{Col. 7}}{\text{Col. 9}} \times L$	$\frac{\text{Col. 8}}{\text{Col. 9}} \times L$	Maximum Deviation of Cols. 6 and 11 Per Cent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Fig. 2(b)	0.200L	0.336L	$0.092L^2$	2.17	3.65	0.25L	0.45L	$0.125L^2$	2.0	3.60	1.4
Fig. 2(c)	0.175L	0.279L	$0.0755L^2$	2.32	3.69	0.25L	0.45L	$0.125L^2$	2.0	3.60	2.4
Fig. 3(b)	0.215L	0.370L	$0.0106L^2$	2.12	3.65	0.25L	0.45L	$0.125L^2$	2.0	3.60	1.4
Fig. 3(c)	0.406L	0.686L	$0.376L^2$	1.082	1.825	0.5L	0.9L	$0.5L^2$	1.0	1.80	1.4
Fig. 4	0.436L	0.754L	$0.415L^2$	1.05	1.82	0.5L	0.9L	$0.5L^2$	1.0	1.80	1.1
Fig. 4	0.197L	0.329L	$0.0901L^2$	2.18	3.65	0.25L	0.45L	$0.125L^2$	2.0	3.60	1.4

$\frac{wL^2}{8} = 112{,}500$ or $w = \frac{112{,}500 \times 8}{40 \times 40} = 563$ lb. per lin. ft. Increasing this value by 5 per cent would give $1.05 \times 563 = 591$ lb. per lin. ft. as the equivalent uniform load for positive moments in the continuous beam.

DIAGRAMS FOR EQUIVALENT UNIFORM LOADS

The value of uniform loads corresponding to concentrated loads of definite magnitude and spacing can be taken from a diagram such as Fig. 7. These curves, calculated for a series of trucks, are applicable to any loading with the same spacing and the same ratio of wheel concentrations.

ACCURACY OF RESULTS

The moment diagrams in Fig. 8 give a comparison of the values that were obtained for a three-span, continuous girder by using both uniform and concentrated live loads. Evidently the difference in the results is unimportant as compared to the other approximations that are made.

NOTES ON GENERAL USE

In the case of continuous beams and frames, it is obvious that different values for the equivalent uniform loads must be used for the positive and negative moments. For frames or beams with restrained ends, a careful study of the influence lines will usually provide a means of obtaining equivalent uniform loads that are consistent with the usual approximations.

Our Readers Say—

The Cofferdam in Boulder Canyon

DEAR SIR: The article by Dr. Elwood Mead on the Hoover Dam correlates all the various features of this great flood control, irrigation, storage, and power development project. The writer wishes only to comment briefly on the first step in the work, which is discussed by Dr. Mead under the head of "River Control During Construction."

During the 28 years of record, the peak of the flood at Boulder Canyon has ranged from a minimum of 52,000 to a maximum of 210,000 sec-ft. The four tunnels, 50 ft. in diameter, can easily pass floods considerably in excess of this maximum and it is only in a year of exceptional flood that it is possible the cofferdams may be overtopped and damaged, or even partly destroyed.

The diversion tunnels will be built so near the ordinary stream level that at low water only a small obstruction in the river will be needed to divert it through the tunnels, but this must be increased into a substantial cofferdam during the low-water period to provide for the ensuing flood stage.

Although bedrock under the upstream cofferdam is only about 60 ft. below the stream bed, it lies at a depth of 100 ft. or more under the main dam. The lower part of the stream-bed material is a mixture of sand, gravel, cobblestones, and boulders. The upper part is a mixture of fine sand and silt, which scours away as the river rises and is filled back as it drops. It is upon this very unstable material that the cofferdam must be started. Evidently, the loose rock fill which must be used to start the cofferdam, and to form its downstream toe, will sink deeply into and displace the light sand and silt of the stream bed. Fortunately, the capacity of the diversion tunnels designed to by-pass the flood flow is so large compared with the much smaller river flow at the proper stage for starting the diversion, that the cofferdams do not have to be built against any considerable head or velocity of flow.

It is necessary, however, that the utmost expedition be used in raising cofferdam embankments far above the height required to by-pass the low water flow, in order to prevent their being overtopped by a sudden rise coming out of season. The ordinary high-water peak comes in May, June, or early in July, but in about one year out of four during the period of record, there is a short flood period not exceeding 120,000 sec-ft., usually in September or October, but occasionally in August.

When enough loose rock filling has been used to bring the cofferdams above the river surface and divert the river through the tunnels, finer material can be employed for the body of the cofferdam embankments, such as gravel, of which there is an abundance within reach upstream from the dam, or tunnel muck, of which there will be a great excess over the requirements of the cofferdams, and which can be conveniently placed in spoil banks within easy hauling distance. The finer material needed for back-filling can be taken from the river or from sand bars upstream from the mouth of the canyon.

The proposed type of cofferdam is especially adapted to the conditions because it uses only local materials, of which there are unlimited quantities, and which can be easily and cheaply handled. Breaks can be easily repaired and even the waste from the excavation for the dam base can be used to strengthen or repair the cofferdams.

The combination of loose rock, tunnel muck, bank gravel, and river sand and silt will make a safe cofferdam; and the combination of safe cofferdam with diversion-tunnel capacity sufficient for any probable flood will overcome the only hazard in the dam construction.

A. J. WILEY, M. Am. Soc. C.E.
Consulting Hydraulic Engineer

Boise, Idaho
November 6, 1930

Increasing Foundation Pressures

DEAR SIR: In his very readable paper, which appeared in the October issue of CIVIL ENGINEERING, Dr. Mead has well described the Hoover Dam as a "colossal enterprise," which it certainly is in every respect—as regards the volume of water stored, the height of the dam, and the electrical energy developed. For years the engineers of the Reclamation Service have been studying this project and it is, therefore, not surprising that this paper is replete with interesting practical details, which it would be impossible for an outside engineer to discuss intelligently.

One feature of the plans, of great importance to engineers, concerns the height of the dam, over 700 ft. This is about double the height of any existing dam, with the sole exception of the Schraeh Dam in Switzerland, which has a maximum height of 366 ft. above the lowest elevation of the foundation.

One question will immediately be asked by engineers interested in masonry dams: What will be the maximum pressure in the masonry for so high a dam? Dr. Mead tells us that this will not exceed 30 tons per sq. ft., a pressure much in excess of what has been customary for high masonry dams. The limit of this pressure has been steadily raised. It may be of interest to glance briefly at this development.

The first masonry dam designed according to scientific principles was the Furens Dam, built from 1862 to 1866, near St. Etienne, France. Delocre, who made the plans for this structure, adopted for the safe limit on the masonry a pressure of 6 tons per sq. ft., both on the downstream and upstream faces. This dam, with its maximum height of 164 ft., was for many years the highest in existence.

In 1884 and 1885, the engineers of the Aqueduct Commission of the City of New York were called upon to design a dam across the Croton River at the Old Quaker Bridge. This structure was to have a height of 275 ft., or 100 ft. more than the Furens Dam. Plans were prepared under the direction of the late Alphonse Fteley, Past-President Am. Soc. C.E., as Chief Engineer. If Delocre's low limit of safe pressure on the masonry (6 tons per sq. ft.) had been adopted, the dam would have had a great width of base, involving much expense in excavating the foundation trench, which would have had to go down about 130 ft. to a satisfactory rock foundation.

However, the engineers knew that the maximum pressure in the Alicante Dam, constructed in Spain from 1579 to 1594, was 11.54 tons per sq. ft. They also knew that the greatest pressure on the masonry in some arched dams, built in New South Wales, Australia, as described in the *Proceedings of the Institute of Civil Engineers*, Vol. 178, was 25 tons per sq. ft.

After a careful study of tests made on concrete, Mr. Fteley fixed the limit of safe pressure on the masonry and the foundation at 16 tons per sq. ft. With this condition, the base of the dam would have had a width of 206 ft. The dam, however, was never built, but the plans made for it were adopted for the New Croton Dam, which was built from 1895 to 1907, at a site $1^1/_4$ miles upstream from the location originally adopted for the Quaker Bridge Dam.

This brings us to the Hoover Dam, for which the engineers have adopted 30 tons per sq. ft. as the limit of safe pressure on the masonry and on the foundation, almost double the limit fixed for the New Croton Dam. While this seems to be a great increase, the maximum compressive stresses in the Coolidge multiple dome dam, in Arizona, recently completed, are, according to Fred A. Noetzli, M. Am. Soc. C.E., about 43 tons. But in this case the masonry is undoubtedly reinforced with steel.

Dr. Mead and his assistants are to be complimented on the great piece of construction they have before them. The completeness of the plans at this stage give ample evidence of the able manner in which the work is being handled.

EDWARD WEGMANN, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
November 7, 1930

Unit Strength of Welds

DEAR SIR: I am thoroughly in accord with Frank P. McKibben's recommendation that, for the present, the working stress for, say $^3/_8$-in. fillets should not exceed 3,000 lb. per lin. in., regardless of reinforcement. As he says, it would usually be uneconomical to provide reinforcement, but there is an additional reason. In a fillet of quadrant shape, the critical dimension is not the throat but the fusion zone at the legs. This is explained in a paper on "Structural Steel Welding" published in the Year Book of the American Iron and Steel Institute, 1928.

In a short paper the author could not cover every point. One feature not mentioned that seems important is the fact that, while the unit strength under static load, of welds aligned normal to the direction of stress, is slightly higher than that of welds aligned parallel to the direction of stress, there is evidence that the strength of the latter under impact is much superior.

F. T. LLEWELLYN, M. Am. Soc. C.E.
Welding Committee, United States Steel Corporation

New York, N.Y.
November 3, 1930

Arc Welding Has Its Place

DEAR SIR: I would emphasize especially this one sentence from Professor McKibben's article, appearing in the October number of CIVIL ENGINEERING, "As the process has certain decided advantages, it should be the aim of structural engineers to guide its growth in safe channels, to use it when desirable, and to exclude it when not." In the application of welding, enthusiasm should be tempered with judgment and with the realization that there are many places where riveting remains the better method of fabrication. The use of welding will broaden as experience indicates safe and economical lines for its development.

No factor in the success of a welded structure is more important than the design; time and thought spent at this stage will be well repaid. During a recent inspection of an all-welded industrial building by a large group of men, the feature which drew frequent comment was the simplicity of the structure. This very simplicity represents a careful study of all the details, none of which were too insignificant to receive attention.

The engineer who would design an economical welded structure must lay aside some of his ideas and practices in riveted work. The mere substitution of welds for rivets is far from being enough; it must be accompanied by modifications in the connections and the make-up of the sections and changes in the methods of shop assembly and field erection. For example, riveted work is assembled in the shop by bolting, but the parts of welded work must be clamped together or held in place by means of jigs until the welding has been done. Jigs can

be used to advantage only when there is duplication, which is always a desirable feature in structural work, but especially so when using welding.

In his discussion of plate girders, Professor McKibben has pointed out the possible economies to be obtained with welding. Roof trusses present opportunities for similar savings, and in them economy results largely from two features: first, the use of gross instead of net sections in the design of tension members; and second, the elimination of gusset plates at joints. This saving is principally in weight and must be maintained by layouts which make for simple shop work.

One of the important applications of welding is in the repairing and strengthening of existing structures to provide for increased loads or for the decreased sections due to corrosion. Bridge engineers have found this a very effective method of attaching additional material to girder flanges and truss members without disturbing the original material. In a recent job of erecting an addition to an office building, the new steel was welded to the old. By so doing it was only necessary to remove a small amount of brick and fireproofing on one face of the old steel.

H. M. PRIEST, M. Am. Soc. C.E.
Assistant Engineer,
American Bridge Company

New York, N.Y.
November 3, 1930

Nine Welding Advantages on a Specific Job

TO THE EDITOR: I have read with interest the paper which F. P. McKibben wrote on the subject of "Arc Welding on Steel Buildings," contained in the October issue of CIVIL ENGINEERING.

The construction of our 14-story office building in Boston, containing about 1,300 tons of steel in the frame, has recently been completed. This building is approximately 110 ft. long, by 58 ft. wide, by 178 ft. high, from the sidewalk to the top of the sign platform on the elevator penthouse.

The following specific advantages were found as a result of welding the steel frame of this building:

1. Construction noise was virtually eliminated.
2. Cost of erecting and welding the steel was $3.00 less per ton than with riveted construction.
3. Accident hazard was greatly reduced by absence of falling rivets. In another local construction enterprise, where rivets were used, serious trouble was encountered.
4. Fire hazard was also reduced by the elimination of hot rivets.
5. Progress on the welded construction equaled the speed of riveting.
6. The welded building frame was more rigid than riveted construction; ordinary structural clearances allowed were not needed. Derrick work proceeded without shaking or swaying of the frame.
7. Alterations made necessary by errors or changes were more easily made than on a riveted structure.
8. Welding required simpler and less expensive stagings than riveting.
9. Smaller gussets were used for wind bracing with the welded structure.

J. L. FADEN
Edison Electric Illuminating Company of Boston

Boston, Mass.
November 10, 1930

Noise Elimination in Field Erection

DEAR SIR: At the present time I do not believe any one in particular has found it economical to substitute shop welding for fabricated shop riveting in structural practice, and as Professor McKibben points out in the October number of CIVIL ENGINEERING, it will be some time before welding will supplant shop riveting, if ever.

Field welding on an office building of a limited number of stories, will compare very favorably with field riveting. In fact, the actual cost of the welding will generally be very little more than the riveting. The added cost of the welded job, if any, is due to the fact that the erection crew holds up construction on a welded building to a greater extent than it does on a riveted job. In other words, erection is somewhat slowed up on account of welding. This feature, I think, can be overcome by careful planning of the job.

At the present time, the main advantage of field welding is not a reduction in cost but the elimination of noise, ease in making connections to old construction, and in doing all erection work.

STACEY H. WIDDICOMBE, M. Am. Soc. C.E.
District Sales Manager,
Shoemaker Bridge Company

Philadelphia, Pa.
October 16, 1930

Two Dumpers Compared

DEAR SIR: It was with a great deal of interest that I read the various papers in connection with the Toledo car dumper, published in the November issue of CIVIL ENGINEERING, particularly the one on "Structural Design and Details," by Wendell P. Brown, M. Am. Soc. C.E.

Of the various types of car dumpers, stationary,

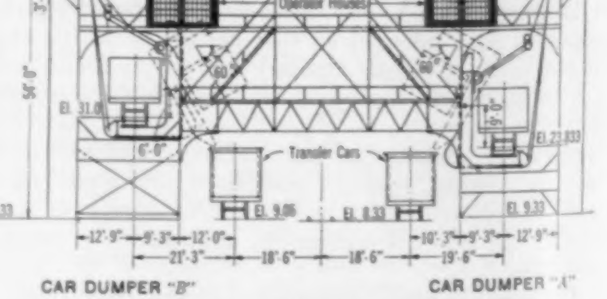


FIG. 1. DOUBLE CAR DUMPER AT LAMBERT POINT
For the Norfolk and Western Railroad

movable, and lifting, it seems to me that the lifting car dumper presents more interesting problems to the structural designer than either the stationary or movable type. Although a car dumper is primarily a mechanical device, nevertheless, the design of the structural framework is probably the most important. It is a well-known fact that machines such as car dumpers, unloaders, and bridges, used for handling both coal and ore, are eventually called upon to handle loads greater than those for which they were designed. It is therefore necessary that the designer of these structures be very thorough in his analysis of the stresses produced by the various operations while in service.

I was impressed by the large increase in railroad car capacities as used today for designing, when compared with those used 18 years ago. This is shown in the following tabulation:

	Norfolk and Western Railroad Dumper	New York Central Railroad Dumper
	Lambert Point	Toledo, Ohio
Maximum car length	51 ft. 5 in.	58 ft. 6 in.
Maximum car width	11 ft. 0 in.	11 ft. 0 in.
Maximum car height	12 ft. 6 in.	13 ft. 0 in.
Maximum car weight	65,000 lb.	90,000 lb.
Maximum car capacity (coal)	195,000 lb.	240,000 lb.
Maximum total loaded weight	260,000 lb.	330,000 lb.

Mr. Brown mentions some of the loads which must be considered in designing the pan girder, one of them being the loads on the hinge pins for the cradle. These loads vary considerably in intensity. Figure 1 shows an end view of the Norfolk and Western Railroad stationary double-car dumper, built in 1912, and Fig. 2 shows in a graphical manner how the loads vary on the hinge pins for the two cradles on this dumper. The loads on the hinge pins are based on a total load for car, coal, and cradle, of 408,000 lb. (for the Toledo car dumper this load is 645,000 lb.).

It would be interesting to see a similar graphical presentation of the various loads which are applied to the pan girder for the Toledo car dumper.

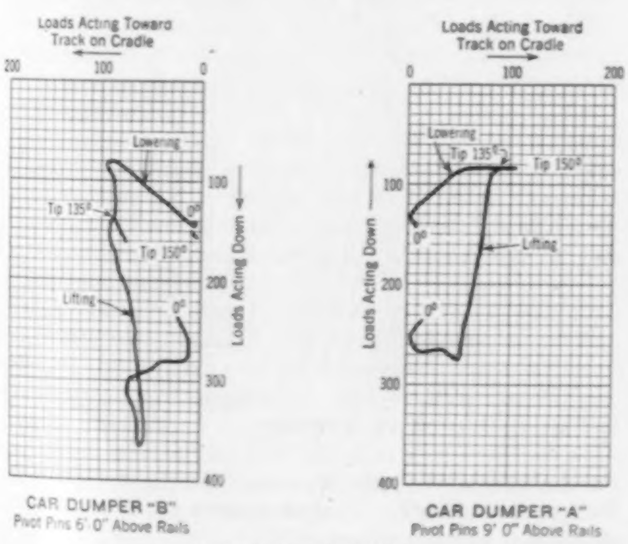


Fig. 2. Variation in Loads on Hinge Pins

Graphic Records for Two Cradles of Norfolk and Western Railroad Car Dumper

Ed. Linders, M. Am. Soc. C.E.
Engineer of Design,
Department of Public Utilities

Cleveland, Ohio
November 13, 1930

Car Dumper Establishes a Record

Sir: My description, in the November issue of Civil Engineering, of the plant and method by which the New York Central Railroad at Toledo loads six million tons of coal, contains a statement that under favorable conditions the dumper will handle a car of coal per minute.

On August 24, the Steamer *Thomas F. Cole*, was loaded at the South Car Dumper at our Toledo Dock. The total time the boat was at the dock was 4 hr. 58 min. The delays to the dumper on account of shifting the boat during this period amounted to $45^1/_2$ min., which left 4 hr. $12^1/_2$ min., the time during which the dumper was actually operating. In this time the dumper emptied 243 cars, containing 12,763 tons of coal, into the boat. The average number of cars dumped per hour during the entire elapsed time of 4 hr. 58 min. was 48.93. The average number of cars dumped per hour while the dumper was actually operating (4 hr. $12^1/_2$ min.) was 57.75. This, we understand, is a record performance on the Great Lakes.

J. A. Stocker
Chief Engineer, Ohio Central Lines of the New York Central Railroad

Columbus, Ohio
October 27, 1930

Let the Engineer Help Himself

To the Editor: Much has been said and written concerning the lack of universal recognition and of fitting compensation for the engineer. The work of the Society's Committee on Salaries has emphasized still more the need for a careful study with a view to solving these problems.

On the engineer rests the responsibility of becoming an increasingly aggressive and effective force in the communities of the world. Undoubtedly, the World War first brought him into universal prominence. In fact, this terrible conflict roused him from his complacent and routine attitude and gave him a broader vision. Having thus emerged, he must not return to his pre-War status, but must continue to take a large part in the world's work.

In recent years, the question has been raised as to whether the engineer's condition is not largely his own fault. It is true that he has always been the faithful and effective pioneer and servant of humanity, but he has rarely been its leader. Studying the situation in various communities, we realize that the engineer is a relatively insignificant figure compared with the members of the so-called "three learned professions." Rarely

does he get as close to his client as does the lawyer, doctor, or clergyman. Instead, he has always been something of a "hired man," since he has worked for, rather than with, others. What, then, can the profession do to train, encourage, and assist its members in bringing about a closer relationship with other groups in the community?

One disquieting result of this social relationship is undoubtedly the development among members of the engineering profession of an "inferiority complex." Probably this, to some extent, is responsible for the relatively low rate of compensation which the engineer receives for his services. Other factors are also involved, among them the increasing use of the word "engineer" to describe various vocations and classes of work which are not professional in character.

Both the engine man on the locomotive and the operator of the village power plant are, in their own parlance, "engineers." In recent years social workers, plumbers, and even bootblacks have used this word to attract attention to their callings. Steps should be taken by the profession either to limit the use of the word engineer or to adopt some other term that will distinguish the professional engineer as a member of a select and learned group, as is done in European countries.

In many sections of the country may be found men who are little better than corner finders, plumbers, or wood butchers, who advertise themselves and endeavor to practice as civil, sanitary, and construction engineers. As may well be imagined, the fruits of their labors do not reflect credit on the profession. Undoubtedly, through the adoption and rigid enforcement of licensing and registration laws by all the States, standards of practice may be put on a high plane.

It is on the profession itself that the responsibility rests of educating the general public to a true understanding of the nature, scope, and value of the services of the professional engineer. This educational campaign involves considerable legislative work, and in this the engineer should take a prominent part.

If engineers do not set a high value on their services, no other member of society will. A recent, only too typical case illustrates this. A survey was made for a proposed housing development involving highly specialized training and experience. As the survey and the resulting report involved only a few days of actual time in the field and office, it was thought that the land company should be charged $100. Before the bill for services was presented, however, a conference was held with the attorneys for the company. These members of the legal profession were shocked at the low value which the engineer placed upon his services and intimated that it would reflect upon the character and value of the report. Upon the advice of the attorneys, therefore, the engineer made a charge of $500, and the bill was promptly paid.

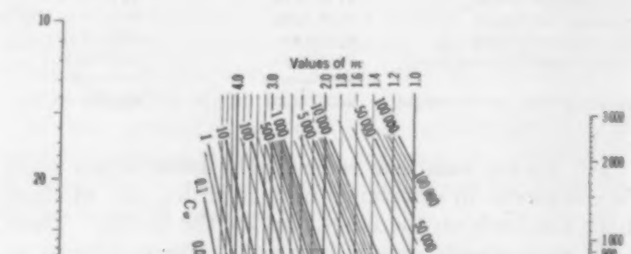
One of the impressive steps recently taken by the Society has been the establishment of a professional division of activities which will include a study of the status of the profession, salaries of engineers, services, and fees. All the committees working in this field may well concentrate upon a study of the fundamental factors that have affected, and continue to affect, the status and welfare of the engineer. The basic difficulties are sociological and psychological conditions in the lives of members of the profession, and these must be changed before economic and professional conditions can be materially and permanently improved.

ALLEN B. McDANIEL, M. Am. Soc. C.E.
Vice-Chairman of the Society's Committee on Salaries
Secretary-Treasurer, The Research Service, Inc.

Washington, D.C.
November 12, 1930

Diagram for Reservoir Capacity Corrected

TO THE SECRETARY: Referring to the paper by Mr. Sutherland entitled "Some Aspects of Water Conservation," as published in the September PROCEEDINGS, an error has been noted in Fig. 4, on page 1515. The scale



on the left of the page, showing "Height of Dam, h_1 in Feet," is evidently numbered wrong. The corrected diagram is submitted herewith.

JOHN W. PRITCHETT, Assoc. M. Am. Soc. C.E.
Engineer, State Board of Water Engineers

Austin, Tex.
October 29, 1930

An Error Corrected

To the Editor: In reading over my discussion, "An Analysis of Bending Stresses," in the November issue of Civil Engineering, I note that an error has been made in the printing, on page 110.

The writer's preferred formula for bending stresses in an operating rope is given as $f = \frac{Ed}{D}$, in which

d = diameter of largest outer wire in strand,

E, $\left(\text{not, as printed, } \frac{Ed}{D}\right)$ = modulus of elasticity of rope in pounds per square inch.

C. D. Meals, Assoc. M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
November 8, 1930

Practical Factors in Excavating Materials

To the Editor: A. E. Holcomb's article on "Output Factors for Excavation and Material Handling Equipment," in your October issue, very clearly and thoroughly handles the theoretical problem of digging the material. I was particularly interested in the fact, however, that it did not discuss what, to my mind, is the most important factor entering into excavation production problems, namely, the disposal of the material. On most excavation jobs we are able actually to dig with our shovels more yardage per day than we are able to dispose of properly on our fills, and are therefore forced to curtail the production of our shovels to the amount we are able to dispose of. In estimating excavation work, it is very important to take into consideration, not the yardage the shovel will dig up per day, but what the shovel will dig and you will be able to dispose of.

Fills might be considered as two classes, railroad and highway. In the former, the excavated material is dumped over embankments and leveled off, while in the latter it is leveled off and rolled in from 4- to 8-in. layers, depending on the depth of the fill and the specifications. It can readily be seen that more material can be handled per day, at a cheaper cost per yard, in the former than in the latter.

Another important factor entering into excavation output is the length of haul of the excavated material. It is an assured fact that the shorter the haul, the easier it is to keep haulage units under the shovel at all times, and consequently cut the time lost at the shovel for this reason to a minimum.

Many other "factors" enter into excavation jobs such as: width and depth of cuts, width and depth of fills, character of material to be excavated, accessibility of fills for haulage equipment, and weather conditions, each of which tends to reflect on the output record and more especially on the cost per yard.

In this article, I notice under the heading "Standard Clamshell-Bucket Crane Work" two tables marked Table III and Table IV. The production shown in these tables may possibly be maintained, providing the cars are not completely unloaded. However, in unloading from a 50-ton gondola car, the bottom 10 tons of material take longer to unload than the top 40 tons, inasmuch as the bucket must be spotted each time, and half of the lower 10 tons must be shoveled into the bucket by men.

For example, suppose we use a 1-yd. bucket and are claming sand from a gondola car into a stock pile; Table III gives us 2.0 cars per hr. and, applying the factor from Table III, or 1.2, the result shows 2.4 cars per hr., or 120 tons per hr. This production may be maintained while unloading the top 40 tons, but, from a practical standpoint, considering loss of time for the lower 10 tons and also for shifting cars under the clam shell, I would suggest this factor should be reduced 50 per cent.

I hope this discussion will bring out, to the contractor or engineer, the importance of considering all the different factors entering into excavation work, each of which is very important in the final analysis of production records and unit costs.

J. Lee Plummer, Jr.
President, J. Lee Plummer, Inc.

Sewickley, Pa.
November 13, 1930

Science the Servant of Civil Engineering

The Editor: There is a long standing tradition in the English-speaking world that science is the servant rather than the source of civil engineering. Practice has been extended cautiously by a combination of analysis and of trial-and-error experiment, followed by a more complete rationalization. Some of the pioneers who labored for more secure scientific foundations—Vignoles, Wheatstone, Playfair, Rankine, and Jenkyn—were good-naturedly set aside by their contemporaries as "hypothetical engineers." As Dr. Flinn observes, in the October issue of Civil Engineering, "It is not easy to stir the older engineers to more than inert interest" in research.

The emphasis on research among electrical and chemical engineers is a natural outgrowth of the history of their professions. The science came first and the art grew out of it. Research in these fields has been greatly aided by the fact that the physical media concerned are of a uniform and homogeneous nature, within the limits of the engineer's concern. As civil engineering, to borrow Dr. Flinn's apt phrase, deals with "substances and forces in the gross," the research worker is always beset by discontinuities of material and secondary forces which are extremely difficult to control. Where both surface and volume relations are complexly involved, the principle of similitude, on which all reduced-scale observation proceeds, is very difficult of application. Nevertheless, immense progress has already been made by these methods, especially in the realm of hydraulic construction.

Dr. Flinn, as director of a research agency, may seem to have the optimism of a special pleader. Judging his paper in the light of things seen and heard in many laboratories, both at home and abroad, my feeling is that he has fully observed the traditions of his profession in allowing an ample margin of safety.

William E. Wickenden
President, Case School of Applied Science

Cleveland, Ohio
November 5, 1930

SOCIETY AFFAIRS

Official and Semi-Official

Consulting Fees Studied

An analysis of replies received from 189 civil engineers to an inquiry concerning the per diem fees they receive for consulting service, permits of several interesting observations.

The 322 engineers selected for inquiry included many of the unquestioned leaders in the profession. Practically every State in the Union was represented. Most of them were consulting engineers, as that term is commonly understood. A few, however, were engineers known to be regularly employed on a salary basis but who upon occasion serve in an advisory capacity on other engagements for a per diem fee.

TERRITORIAL VARIATIONS

Section	Number of Men	Average Age	Average Years Experience	Professionally Connected with Work of Value (Average)	Ratio of Fees (Average)
Western	31	55	33	$86,000,000	1.00
Southern	31	54	31	90,000,000	1.16
Northern	14	56	33	177,000,000	1.25
Eastern	29	59	37	164,000,000	1.42
National and International	67	61	38	324,000,000	2.27
Averages	172*	58	36	$200,000,000	

* Seventeen reports were received incomplete in one or more important details, making the total number of replies 189.

AGE NOT MAJOR FACTOR

The data showed that neither age nor years of experience is a major factor in the size of fee obtainable. With 40 to 45 years engineering experience the very highest rates are possible. With 35 years of experience the spread of the fees is considerably restricted and averages at about $100 per diem. With 30 years experience the range is somewhat wider, with the usual fee approximating $50 per diem. There are sufficient exceptions, however, to indicate that length of experience alone is not a basis for appraisal as to worth of services.

ENGINEERING SPECIALTIES

Types of experience in one or another of the several fields of civil engineering have a discernible value as shown by the following table:

Type of Experience	Relative Fee
Highways	1.00
Irrigation, Drainage, Flood Control	1.06
Municipal and General	1.18
Sanitary and Water Supply	1.28
Buildings, Foundations, Dams	1.40
Bridges	1.46
Railroads, Transportation, Tunnels	1.52
Power, Transmission, Industrial	1.53
Rivers and Harbors	1.58

CONSULTATION SPECIALTY

Types of consulting service also show a definite variation. It must be realized, however, that the duration of engagement may differ widely, perhaps resulting in total remuneration more nearly of an equality. This is particularly true of court testimony as contrasted with design or supervision of work. Service in Government or State matters is strikingly unremunerative.

Type of Consulting Service	Relative Fees
Government or State	1.00
Supervision and Inspection	2.35
Valuation	2.74
Design and Construction	2.77
Examinations and Reports	2.83
General (all kinds)	3.26
Court	3.47
Arbitration	3.83

TERRITORIAL VARIATIONS

The replies were divided into five territorial groupings in connection with which certain characteristics were observed.

The practice in the Western section is well distributed over the field of engineering, with preponderance of irrigation and drainage work. In the Southern section no branch of engineering stands out prominently. For the Northern section consulting service in sewerage, water supply, and other municipal lines predominates slightly. For the Eastern section the same is true. National or international work is along all possible lines. Taken all in all, water supply, sanitation, and buildings and bridges prove to be the fields in which consulting service is most frequently rendered on the per diem basis.

SIZE OF WORKS PROVIDING EXPERIENCE

Even to engineers, the cost of work, with which those reporting state themselves to have been in contact, and from which their experience is derived, show as very large figures.

8 reported contact with more than $1,000,000,000 each
19 reported contact with between $500,000,000 and $1,000,000,000
18 reported contact with between $250,000,000 and $500,000,000
68 reported contact with between $50,000,000 and $250,000,000
59 reported contact with work of $50,000,000 or less

The combined total for the engineers replying reached the colossal sum of $34,348,000,000.

It is on the basis of experience, in terms of magnitude of work with which contact was had, that the variations in fees charged are most clearly proportioned. There are, however, three side lights of significance.

First, it is apparent that those regularly on salary charge fees upon occasion on two widely varying bases. On the one hand those regularly employed on large operations, who upon occasion render consulting service elsewhere, receive the larger of the fees, whereas those regularly employed as teachers or professors in engineering schools state frequently that they charge fees from $25 to $50 per diem.

Second, again on the basis of contact with extensive work, it is observable that those receiving the greater remuneration do so to a very appreciable extent on the "retainer" basis. A retainer of $10,000 plus $250 per diem is reported. Retainers running from $1,000 to $2,500 plus $100, $150, or $500 per diem are reported. More commonly the amount of retainer is not stated and per diem rates are quoted, in addition to retainer, as $100 or $200 per day.

Third, special knowledge or special ability enables the receiving of fees of any size that the circumstances warrant.

ACTUAL FEES OBTAINABLE

The following table expresses fairly well in round figures the cost of engineering work from which experience is gained and the actual fees charged:

Contact with Work Costing:	Per Diem Fees Charged
Up to $30,000,000	$50
100,000,000	100
200,000,000	150
350,000,000	200
500,000,000	250
750,000,000	300
More than 750,000,000	500 and 1,000

As will be noted, the analysis brings out some exceedingly interesting data. Although there may have been lack of precision in the questions asked, the averaging of such a sizeable group of replies appears to give a fairly reasonable picture of the relationship between years of experience, branch of engineering, and nature of

services rendered, value of associated work, and, to a less precise extent, the amount of per diem fees.

Respectfully submitted,

J. Vipond Davies, M. Am. Soc. C.E.

Chairman of the Society's Committee on Fees

November 15, 1930

Annual Meeting Next on Program

Preliminary plans are now being perfected for the 1931 Annual Meeting of the Society. This year the date is somewhat later than usual, January 21–23. Many of the features which have always made these meetings so attractive to a large number of members will be found in the 1931 program, while other distinctive elements will be introduced.

In addition to the routine of the annual meeting itself, on Wednesday morning, the interesting custom of awarding prizes will be observed. Then, too, there is an award of Honorary Membership to be bestowed, either at that session or at one of the other formal gatherings.

Several of the divisions have planned interesting programs on up-to-date topics. "Wind Bracing in Tall Buildings" will be the subject for the Structural Division, while the oft-discussed matters of "Pre-Qualification of Contractors and Equitable Distribution of License Fees and Taxes" will receive consideration in the Highway Division. The Power Division, on the other hand, will take as its main topic the "Use of Gas for Developing Electric Power," a matter which is much in the foreground of engineering interest at the moment. Other divisions will likewise arrange suitable meetings.

On the social side, ample preparation is being made to insure that every member will enjoy his visit. Several interesting possibilities are being considered for the all-day trip to some point of engineering interest within reach of New York City. For this event, a pleasing trip, an enjoyable lunch, and a valuable opportunity for social contact are promised.

Excellent arrangements have been perfected for holding the Dinner Dance in the main ballroom of the Roosevelt Hotel. In addition, there will be numerous college alumni reunions, a subway inspection trip, and all the other features that have gone to make the annual meeting a red-letter occasion in the events of the Society's year. Within the month, full details will be forthcoming in the shape of the official program. All that remains is the perfection of minor details. An attractive layout for these events is assured and the usual large attendance is in prospect.

President Coleman Visits Local Sections

Preceding the St. Louis Meeting, President Coleman went to Urbana, Ill., where he visited the Student Chapter at the University of Illinois and the Central Illinois Section. Following the meeting, he visited Nashville, Dayton, Columbus, Pittsburgh, Richmond, Jacksonville, Savannah, Atlanta, Auburn, and Montgomery. At each of these cities, he was asked to address either Local Sections or the local engineering society, which included many Society members. He was also invited to address Student Chapter groups at Vanderbilt University, the Georgia School of Technology, and the Alabama Institute of Technology. There were present large student groups in the meetings at Columbus and Pittsburgh. Mr. Richmond, Assistant to the Secretary, accompanied Mr. Coleman.

Manuals Have a Purpose

In the *Manual of Procedure for Technical Divisions* is contained a statement of the purpose, scope, and contents of manuals as distinguished from papers. For the benefit of all who may be interested, it is again printed here.

"A manual, in distinction to a paper which expresses only an author's observations or opinion, is to consist of an orderly presentation of facts on a particular subject, supplemented by an analysis of the limitations and application of these facts.

"It is to contain information useful to the average engineer in his every-day work, rather than findings that may be used only occasionally or rarely. It is, however, not to be in any sense a 'standard' nor is it to be so elementary or so conclusive as to provide a rule-of-thumb for non-engineers.

"As to subject matter, it may take any one of several forms:

"1. It may consist of an outline of a particularly successful solution of a general type problem, for example, a detailed account of the means, devices, personnel, cost, etc., of a particular survey in which a great deal of 'pioneering' was done to arrive at the most effective solution.

"2. It may consist of the assembling of all the facts relating to a general phenomenon, for example, all available data relating to silting velocities in canals; or Manual No. 4, *Bibliography on Construction Plant and Methods.*

"3. It may consist of a collection of the definitions of terms used in a particular branch of engineering, for example, accepted definitions of the terms used in sewage practice with notes expressing deviations or exceptions. (Manual No. 2, 1929, *Definitions of Terms Used in Sewerage and Sewage Disposal Practice.*)

"4. It may consist of an outline of current practice in some branch of engineering that experience has shown to have become established, for example, that of highway drainage.

"5. It may consist of a symposium of papers or monographs by specialists on a particular topic as the latest word on the subject treated, for example, a symposium on the *Adjudication of Water Rights*, outlining the methods successfully used in various States or between different States.

"6. It may consist of the practical experiences of engineers or builders with respect to some heretofore not well understood process, for example, the grouting of porous or faulted rock.

"7. It may consist of a comprehensive exposition of the many forms of single type of structure, each successful but differing in their adaptability, for example, piles; or Manual No. 3, 1930, *Lock Valves.*

"A manual, in distinction to a paper, is to be the work of a committee or group appointed to assemble and express the information on a particular topic. So far as practicable the committee should be under the auspices of one or more of the Technical Divisions, and the product evolved should be subject to review by the Executive Committee of that Division. As a step in the process of this review, it may be advisable to bring proposed manuals before the members of the Technical Divisions for comment, which comment may serve as the basis for recommendation to the Society with respect to printing, adoption, or promulgation as authentic. When published, each manual should show clearly the names of the committeemen by whom it was compiled, and the several processes through which it has passed in review in order that its merit may be definitely understood."

In this connection the following extract from the March 1929 Proceedings, Part II is of interest:

"Manuals are not papers and are not reports—these are incorporated in Proceedings. Manuals are thoroughly digested expositions of matter not hitherto collated. Each manual, before it can appear as such, must proceed through a series of experiences calculated to make it authoritative. It must be drafted by a group, not one man. It must have been discussed and, in the light of that discussion, revised. It must be subjected to a vote or other test of its acceptability and correctness, and, finally, it must have been approved by the Board of Direction. Thus, it is authoritative.

"It is from the Technical Divisions that manuals of a technical nature are to be expected, and from committees especially appointed that manuals having to do with professional or non-technical matters will evolve."

Engineers Aid to Relieve Unemployment

In all discussion of unemployment the public mind continually reverts to "construction" of one sort or another as a cure. Public works perhaps is mentioned more often than any other single measure. It is not strange, therefore, that engineers should be assumed to have a major interest in the situation, as those who will in large part conceive and direct construction work. Thus one of the major activities of the President's Engineering Committee for Employment centers in its Public Works Section.

In brief its purpose is to influence and assist in placing under construction public and semi-public structures such as buildings, highways, and bridges, and to aid in speeding up projects heretofore authorized. In all this cooperative work American Engineering Council is active on behalf of the profession.

As an initial step it is proposed to list public and semi-public construction projects now authorized but not yet started, and also proposed projects of this character which if undertaken hold promise of giving unemployment relief. Reports on proposed projects are to be limited to (a) those which are generally accepted as sound and economically advisable; (b) those which could be started, say, within six months; and (c) those which involve directly or indirectly a relatively large amount of labor. To secure this information blank questionnaires have been prepared and are being furnished. In gathering this information American Engineering Council will be represented in the field primarily by the Local Sections of the Society supplemented where necessary by the local sections of the other affiliated organizations and by individuals in places where local sections do not exist.

After the questionnaires have been filled out by those best qualified to do so, they are to be sent to the Washington office of the President's Committee. The Public Works Section will study the reports in the hope that some of the obstructions may be removed where projects are found to be delayed or postponed.

In all this activity the purpose is to render practical assistance in the solution of the unemployment problem and to avoid doing anything that will savor of the promotion of selfish interests.

Representing American Engineering Council on this work is C. W. Kutz, M. Am. Soc. C.E. Field agencies being set up in each State are expected to cover the State, dividing this among themselves to best advantage and cooperating on construction of an interstate character. In all, about 135 local agencies will be associated with General Kutz. Directly and indirectly, both as organizers and as practicing engineers, many members will be called upon to serve in this endeavor.

No more worthy agency than Society units could have been selected. This occasion presents an unusual opportunity for the mobilization of these valuable personnel resources.

Final Ballots for Officers

Shortly the final ballot for Society Officers for 1931 will reach each member and, with many, possibly the query will arise as to the necessity therefor. The first and second ballots are of local interest, providing, within the Districts and Zones concerned, for the selection of nominees. The final ballot is the election of the Society's administrative officials, a matter of concern to all members resident wherever they may be.

Then there is the legal point of view. The Society is chartered with certain very definite aims. Its membership is guaranteed certain privileges, among which is that valuable one of voting for its officers. From the standpoint of the Society, these are not local in any sense but are an integral part of the entire organization. The answer, then, is that each member votes for all officers because they are his representatives no matter how nominated.

There is, furthermore, the courtesy extended the selected nominees through an interested participation by the membership in the Society's administration, and the interest in those members who are to contribute much of time and effort to its management.

Publication of Government Water Supply Papers

Steps are being taken to encourage prompt publicity for material on water supply as collected by Government departments, but not yet released for public information. The gist of the argument in this matter is contained in the following resolutions adopted by the Board of Direction of the Society at Cleveland on July 8:

"WHEREAS the United States Geological Survey has been, for many years past, the authorized agent of the Federal Government in the collection and publication of stream-flow records; and

"WHEREAS the prompt publication of such records is of the utmost importance to industrial developments dependent upon water supplies and to the engineers engaged in that class of work, and any delay in publication means a definite economic loss; and

"WHEREAS publication of these records in the Water Supply Papers of the Geological Survey has been long delayed, and is now about four years in arrears for the entire United States,

"*Now, therefore, be it resolved* that the Board of Direction of the American Society of Civil Engineers requests the Secretary of the Interior and the Director of the Geological Survey to expedite the publication of these back records in every way possible, and particularly by introducing and urging the passage of necessary appropriations—either regular or deficiency—needed to finance such publications; and

"*Be it further resolved* that since publication of many, if not all, of these back records constitutes an obligation already assumed by the Geological Survey under cooperative agreements with States and other agencies, the Director of the Geological Survey be requested to give precedence in publication to Water Supply Papers, which come under such contractual obligations, and to delay, if necessary, those less urgent papers comprising Professional Papers, Bulletins, and Water Supply Papers dealing with special subjects, and proportionately increase the allotment, from the regular printing appropriation, for Surface Water Supply Papers until these records are brought up to date."

Further approval of these proposals is contained in the action of the Board of the American Engineering Council. By a strong resolution adopted at its October meeting, it supported the above action.

Technical Divisions Nominate Executive Committees

Each Technical Division of the Society elects an Executive Committee of 5 members of the Division, who shall be members of the Society, to have charge of its affairs under the guidance of the Board of Direction. Each year, as the oldest retires, a new committeeman is added to the Executive Committee, for a 5-year term. He is selected by a letter ballot of members of the respective Divisions from a list of three nominees.

Each Division's nominating committee has forwarded the names of its three nominees to the Secretary of the Society and they have been submitted to the members. The ballots will be issued not later than December 15 and must be returned in time to be canvassed January 5, 1931. The list of nominees submitted follows:

City Planning Division

Carey H. Brown, M. Am. Soc. C.E., Rochester, N.Y.

Jacob L. Crane, Jr., M. Am. Soc. C.E., Municipal Development Engineer, Chicago, Ill.

Charles F. Loweth, Past-President, M. Am. Soc. C.E., Chief Engineer, C.M. & St. P. & P. RR., Chicago, Ill.

Construction Division

Dean G. Edwards, M. Am. Soc. C.E., President, Edwards and Flood, Inc., Brooklyn, N.Y.

D. L. Hough, M. Am. Soc. C.E., Negotiating Engineer, The Foundation Company, New York, N.Y.

George Perrine, M. Am. Soc. C.E., Field Engineer, Rodgers and Hagerty, Inc., New York, N.Y.

Highway Division

Robert H. Baker, Assoc. M. Am. Soc. C.E., Commissioner, State Department of Highways and Public Works, Nashville, Tenn.

E. W. James, M. Am. Soc. C.E., Chief, Division of Highway Transport, Bureau of Public Roads, Washington, D.C.

George B. Sowers, M. Am. Soc. C.E., Commissioner of Engineering and Construction, City of Cleveland.

Irrigation Division

H. B. Muckleston, M. Am. Soc. C.E., Consulting Engineer, Vancouver, B.C., Canada.

J. C. Stevens, M. Am. Soc. C.E., Consulting Hydraulic Engineer (Stevens and Koon), Portland, Ore.

R. K. Tiffany, M. Am. Soc. C.E., Consulting Engineer (Tiffany and Langloe), Olympia, Wash.

Power Division

Harry W. Dennis, M. Am. Soc. C.E., Chief Civil Engineer Southern California Edison Company, Los Angeles.

Walter L. Huber, M. Am. Soc. C.E., Consulting Engineer, San Francisco.

J. C. Stevens, M. Am. Soc. C.E., Consulting Hydraulic Engineer (Stevens and Koon), Portland, Ore.

Sanitary Engineering Division

Charles Gilman Hyde, M. Am. Soc. C.E., Consulting Sanitary and Hydraulic Engineer, Professor of Sanitary Engineering, University of California.

W. T. Knowlton, M. Am. Soc. C.E., Sanitary Engineer, City of Los Angeles.

Richard R. Lyman, M. Am. Soc. C.E., Civil and Consulting Engineer (Lyman and Pack), Salt Lake City.

Structural Division

Montgomery B. Case, M. Am. Soc. C.E., Engineer of Construction, The Port of New York Authority, New York.

T. L. Condron, M. Am. Soc. C.E., Consulting Structural Engineer, Chicago.

Jonathan Jones, M. Am. Soc. C. E., Chief Engineer, McClintic-Marshall Company, Pittsburgh.

Surveying and Mapping Division

R. H. Randall, M. Am. Soc. C.E., President and Chief Engineer, R. H. Randall and Company, Inc., Toledo, Ohio.

U. N. Arthur, M. Am. Soc. C.E., Chief Engineer, Department of City Planning, City of Pittsburgh.

W. M. Beaman, M. Am. Soc. C. E., Chief, Section of Inspection and Editing of Topographic Maps, U.S. Geological Survey, Washington, D.C.

Waterways Division

Richard K. Hale, Assoc. M. Am. Soc. C.E., Associate Commissioner, Department of Public Works, Division of Waterways and Public Lands, Boston.

Charles W. Kutz, M. Am. Soc. C.E., Brigadier General, U.S.A. (Retired), Gary, Ind.

Charles M. Spofford, M. Am. Soc. C.E., Hayward Professor of Civil Engineering, Massachusetts Institute of Technology, Consulting Engineer (Fay, Spofford, and Thorndike), Boston.

Official Nominees—1931

For President, Francis Lee Stewart, of New York
For Vice-President, Zone II, J. N. Chester, Pittsburgh
For Vice-President, Zone III, Henry M. Waite, Cincinnati
For Directors:

District No. 1, L. G. Holleran, New York and C. A. Mead, Newark, N.J.
District No. 2, Henry R. Buck, Hartford, Conn.
District No. 6, Edwin K. Morse, Pittsburgh
District No. 10, H. D. Mendenhall, Lakeland, Fla.
District No. 13, Frederick C. Herrmann, San Francisco

Ballots will be canvassed at the Annual Meeting in January, 1931

Who's Who in the Annual Election

Of particular interest in connection with the annual election of the Society, ballots of which will be canvassed on January 14, are the following brief biographical sketches of the official nominees:

Francis Lee Stuart

Born at Camden, S.C., in 1866, Mr. Stuart graduated from the Emerson Institute, Washington, D.C., in 1884. In that year he entered the office of the Consulting Engineer of the Baltimore and Ohio R. R. In 1897 he became Assistant Engineer to the Nicaragua Canal Commission; from 1899 to 1900 he was Division Engineer for the Isthmian Canal Commission on plans for the Nicaragua Canal; 1900 to 1905, Assistant Engineer and Engineer of Surveys for the Baltimore and Ohio Railroad; 1905 to 1910, Chief Engineer of the Erie Railroad during four-track open cut work in Jersey City, building of the Erie Railroad, Jersey Railroad, and Genesee River Railroad; 1910–1915, Chief Engineer of the Baltimore and Ohio in charge of Magnolia Cut-Off, Allegheny tunnel work, coal pier at Curtis Bay, Baltimore, and coal and ore docks on the Great Lakes; 1915 to date, Consulting Engineer in New York.

Mr. Stuart served as a technical advisor to the War Board of the Red Cross in 1917; as Chairman of the Terminal Port Facilities Committee of the Storage Committee, 1917 to 1918; Chairman of the Budget Committee of the U.S. Railroad Administration in 1919; and in 1920 acted as Consulting Engineer to the Hydro-Electric Power Commission of Ontario. In 1921, he was Engineering Expert to the Port Development Commission of Baltimore, and member of the Transit Advisory Board of the City of Philadelphia; 1924 to 1925, Consulting Engineer of the Greater Harbor Committee of the Los Angeles Chamber of Commerce.

From 1923 to 1926, he was retained by 11 trunk line railroads serving the Port of New York to investigate and report on transportation matters. In 1928, he was Consultant to the Canadian Pacific Railroad in terminal matters in Montreal. From 1920 to date he has been Consulting Engineer of the Hudson River Bridge project. He is the designer-patentee of the Baltimore and Ohio Railroad Belt Coal Pier at Curtis Bay, Md.; of the Government Fuel Yard at Washington, D.C., and other coal-handling plants.

He has been a Director and Vice-President, Am. Soc. C.E., a Director and President of the Baltimore Engineers Club, Director and President of the Society of Terminal Engineers of New York, Vice-President and President of Engineering Foundation, Inc.; and a member of the American Society of Mechanical Engineers, of the Engineering Institute of Canada, of the Institution of Civil Engineers of Great Britain, and belongs to a number of other technical societies and clubs.

John Needels Chester

Born September 24, 1864, in Columbus, Ohio, J. N. Chester received his B.S. in the College of Engineering, University of Illinois, in 1891; C.E. in 1909, and M.E. in 1911. In 1891, he became Field Engineer, National Water Supply Co., Cincinnati; 1892 to 1894, he was Assistant Engineer, American Debenture Co., Chicago, and Coffin and Stanton, 72 Broadway, New York; 1894 to 1899, Field Engineer and Salesman for Henry R. Worthington, New York; 1899 to 1906, Chief Engineer, American Water Works and Guarantee Co., Pittsburgh; 1906 to 1911, General Manager and Engineer, Epping Carpenter Co., Pittsburgh.

From 1911 to date, he has been Senior Partner, Chester and Fleming, now the J. N. Chester Engineers, Consulting Engineers, Pittsburgh. As Consulting Engineer he has provided filter plants for Birmingham, Ala.; Shreveport, La.; Nashville, Tenn.; Jefferson City, Mo.; East St. Louis, Ill.; Muncie, Ind.; Steubenville, Ohio; Wheeling, W. Va.; Erie, Pa.; Batavia, N.Y., and numerous other plants. He has provided sewage purification for numerous cities of Ohio and Pennsylvania, and appraised valuable utility properties.

He has held the following offices: 1912 to 1929, Vice-President and Director Capital City Water Company, Jefferson City, Mo.; 1907 to date, President and Director, Edgeworth (Pa.) Water Co.; 1914 to date, President and Director, Upper Sandusky Water Works Co.; 1928 to date, President and Director, Fayette City (Pa.) Water Co.

He has been a Director, Am. Soc. C.E., and a member of the following organizations: American Society of Mechanical Engineers, American Institute of Construction Engineers, Engineers Society of Western Pennsylvania (Past-President), American Water Works Association, State Registration Board for Professional Engineers of Pennsylvania; and a Fellow of the American Public Health Association.

Henry Matson Waite

Born May 15, 1869, in Toledo, Ohio, H. M. Waite graduated from the Massachusetts Institute of Technology. From 1893 to

1907, he was Division Engineer, Bridge Engineer, Roadmaster, and Division Superintendent, with the Cincinnati, New Orleans and Texas Pacific Ry.; 1907 to 1909, Superintendent Seaboard Air Line; 1909 to 1912, Vice-President and Chief Engineer, the Clinchfield Coal Corporation; 1912 to 1913, Chief Engineer, Department of Public Service, City of Cincinnati; 1914 to 1918, City Manager, City of Dayton, Ohio; 1918 to 1919, Lieutenant-Colonel and Colonel of Engineers, A.E.F., Deputy Director and Chief Engineer, Department of Transportation; Deputy Director of Transportation, Third Army in Germany; Member of the Bridge Head Commission, Coblenz; Assistant to Officer in Charge of Civil Affairs, Advanced Headquarters, Treves, Germany.

From 1920 to 1923, he was Vice-President and Chief Engineer, Lord Construction Company, New York; 1923 to 1927, in private practice, New York; and 1927 to date, Chief Engineer, The Cincinnati Union Terminal Company.

He is a member of the following organizations: American Railway Engineering Association, American Concrete Institute, Institute of Mining and Metallurgical Engineers, Society American Military Engineers, National Committee on Municipal Standards, Advisory Council Proportional Representation League, New York and Cincinnati Engineers' Clubs; Past-President, Member of Council and Committee on County Government, National Municipal League; Past-President, Member of Committee on Qualifications and Selection of City Manager and Editorial Consultant, International City Managers Association.

Leslie Gilbert Holleran

Born October 21, 1881, in Conklingville, N.Y., L. G. Holleran went to Union College, where he received his B.E. in 1906. From June to November of that year he worked as Draftsman for the Owego Bridge Company. From 1906 to 1914 he was Assistant Engineer with the Board of Water Supply, City of New York, working on the construction of the Catskill Aqueduct. From 1914 to 1924, he was Assistant Engineer, Principal Assistant Engineer, and then Deputy Chief Engineer in charge of Engineering and Construction, the Bronx Parkway Commission. From 1924 to date, he has been Deputy Chief Engineer in charge of engineering and construction, Westchester County (N.Y.) Park Commission.

Mr. Holleran is the author of many technical papers on the design and construction of roads, bridges, parkways, grade crossing eliminations, and other subjects.

He is a member of the New York State Society of Professional Engineers, serving as President of the Westchester County Chapter in 1928, 1929, and 1930. He is a member of the American Road Builders Association, of the American Institute of Park Executives, of the Delta Upsilon Club of New York, and of the Colonial Club of Westchester.

Charles Adriance Mead

Born April 1, 1870, at Tuckahoe, N.Y., C. A. Mead graduated from Brooklyn High School in 1888 and became a special student at Pratt Institute. There he was Instructor in Mechanical and Architectural Drawing from 1888 to 1894. From 1888 to 1889, he was Draftsman, Standard Oil Company of New York; 1890 to 1893, Chief Draftsman, Field Engineering Company, N.Y.; 1893 to 1895, Draftsman with Post and McCord, Atlas Iron Construction Company, L. Eidlitz, Jr., of New York, and E. B. Hedden, Newark, N.J., on design and detail of many buildings and bridges. From 1898–1908 he was Principal Assistant Engineer and Office Manager for Boller and Hodge, N.Y., and prepared designs for bridges, buildings, and foundations for the Choctaw, Oklahoma and Gulf Railroad, and the Wabash Railroad; for the Monongahela and Ohio River cantilever bridges and terminal structures; for municipal structures, the Melrose Avenue Viaduct, the 97th St. Viaduct, and for such buildings as the Singer Tower, Manhattan Life, Hotel Renaissance, and various college buildings.

From 1907 to date, he has been Bridge Engineer and Chief Engineer of the Division of Bridges and Grade Crossings, New Jersey Railroad Commission and Board of Public Utility Commissioners, State of New Jersey. From 1917 to 1922, he had charge of grade-crossing elimination throughout the State, and designed, constructed, and maintained all New Jersey State Highway bridges. He served from 1916 to 1918 in the Montclair Battalion and from 1918 to 1920 in the New Jersey State Militia Reserve.

He was President of the New York Section, Am. Soc. C.E., 1929, and is a member of the following associations: American Society of Mechanical Engineers, Permanent Association of Navigation Congress, American Association for the Advancement of Science, American and International Society for Testing Materials, American Concrete Institute, and is an Associate, American Railway Engineering Association.

Henry Robinson Buck

Born September 14, 1876, Wethersfield, Conn., H. R. Buck attended Sheffield Scientific School and received his Ph.B. degree at Yale University in 1896. In 1896 he became Rodman on intercepting sewers, Hartford, Conn., and in 1897, Instrumentman, general sewer construction, City Engineer's Office, Hartford. From 1902 to 1905 he was Assistant City Engineer, Hartford, in charge of office and all sewer, bridge, and paving construction with design and assessments.

From 1905 to date he has been in private practice; from 1909 to 1911, as Buck and Sheldon, Inc.; 1911 to 1912, President and Secretary of Ford, Buck, and Sheldon, Inc., 1911 to 1929, Secretary of Buck and Sheldon, Inc.; from July, 1929, to date, President of Henry Robinson Buck, Inc., independent office doing sanitary engineering, mill architecture, and general surveying.

He represented the State of Connecticut in the re-survey of its boundary lines, was engineer for the State in the erection of the State Arsenal and Armory, Hartford; was engineer member of the State Factory Wastes Commission; and for several years was the local engineer for the New York, New Haven and Hartford Railroad Company, until the organization of its own engineering office in New Haven.

He is a Charter Member, American Institute of Consulting Engineers (Council Member 1929 to date), and a member of the following organizations: Connecticut Society of Civil Engineers (President, 1917), New England Water Works Association (Vice-President, 1919), American Public Health Association, Hartford Engineers Club, Yale Engineering Association, Connecticut Forest and Park Association (Vice-President), Hartford Board of Park Commissioners (Vice-President), and of the Hartford Metropolitan District Commission on Regional Planning.

Edwin Kirtland Morse

Born at Poland, Ohio, July 3, 1856, E. K. Morse graduated from Yale University in 1881 as an engineer, and then took a post-graduate course at the Polytechnic, Carlesruhe, Germany. He was a draftsman with the Morse Bridge Co., 1881 to 1884; Western agent for the same company, 1884 to 1887; and from 1887 to 1889 erected, with S. V. Ryland, the Hawkesbury River Bridge, New South Wales, Australia. Returning to the United States he settled in Pittsburgh where he did general contract work from 1889 to 1893.

Since 1893 he has designed and superintended the Carnegie Steel Company's substructure for a railroad bridge across the Allegheny River and its hot metal bridges at Port Perry and Rankin; he has been Consulting Engineer of Jones and Laughlin Steel Company for 12 years, for the City of Pittsburgh for 4 years, and for Allegheny County, Pa., for 3 years. He has served the City of Pittsburgh as Chairman of the City Planning Commission, as Chairman of the Engineers Committee of the Flood Commission, as Transit Commissioner for 3 years, and as Advisory Engineer on river-front improvement. He designed and superintended the building of three bridges across the Ohio River and many others, requiring the construction of 76 river piers in navigable rivers; he made many railroad and river surveys, designed and constructed large mill and mercantile buildings, and was Engineer Member of the Water and Power Resources Board of the State of Pennsylvania.

He is now President of the Pittsburgh Section, Am. Soc. C.E., and is Past-President of the Engineers Society of Western Pennsylvania.

Herbert Drummond Mendenhall

Born at Gulf Hammock, Florida, on February 7, 1883, H. D. Mendenhall received his B.S. and C.E. from the University of Texas in 1905. In 1905 he became Junior Engineer with the U.S. Engineers in the Tampa District. From 1907 to 1912, he was Chief Designing Engineer for the late C. G. Memminger, Consulting Engineer, on pebble phosphate mining plants in Florida. From 1912 to 1917, in private practice with his father in Lakeland, Fla., as G. D. and H. D. Mendenhall, Consulting Engineers, he handled, among many others, the following projects: concrete lock on the Withlacoochee River for the Florida Power Company; mining plant for the Sangully Phosphate Company; river front terminals for the Commodores Point Terminal Company; examination of the properties of the Peace River Phosphate Mining Company, Fla., and of numerous other phosphate deposits.

From 1917 to 1919, he was Captain of Engineers, A.E.F. in France, among his assignments being: Beau Desert Hospital, 17,500 beds; Talence Hospital, 3,000 beds; and expanding Le Courneau Camps. He was decorated with the Ordre de l'Etoile Noire of the Legion d'Honneur by the President of France.

From 1919 to date he has been in private consulting practice with G. D. & H. D. Mendenhall, Lakeland, Fla.

He is Past-President of the Florida Engineering Society; Past-President of the Florida State Board of Engineering Examiners; Member, Society of American Military Engineers; Chairman, Committee on Membership in Florida, Am. Soc. C.E.; Member, Florida Association of Architects; Past-President, Lakeland Chamber of Commerce; past-member, Lakeland City Commission.

Frederick Charles Herrmann

Born August 30, 1870, at San José, Calif., F. C. Herrmann received his B.S. at the University of California in 1894. After doing land surveying with Herrmann Brothers, San José, in 1895 he became Assistant Engineer with the Salinas Valley Irrigation Company, Kings City, Calif.; and in 1897, Resident Engineer, Spreckels Sugar Company, San Francisco, designing and constructing irrigation systems for ranches in the Salinas and Santa Clara Valleys. From 1899 to 1900, he was Irrigation Engineer, U.S. Irrigation Investigations on Kings River Unit of California for Bulletin No. 100; from 1900 to 1905, Assistant Engineer, City of San Francisco; from 1905 to 1907, Irrigation Engineer, U.S. Irrigation Investigations in Central Division of the United States. From 1907 to 1910, as Assistant Chief and Chief Engineer, California Development Company, he assisted in closing the second break in the river and was in charge of reconstructing and operating the company's irrigation system. From 1910 to 1914, he was Construction Engineer and Chief Engineer, Spring Valley Water Company, San Francisco.

From 1915 to date, he has been Consulting Civil Engineer in San Francisco for domestic water companies, irrigation projects in California, Oregon, Washington, and Hawaii; for reclamation districts along the Sacramento and San Joaquin Rivers; for flood control projects of the State Reclamation Board; and for water resource investigations for the State of California.

He is a member of the following organizations: Seismological Society of America, Commonwealth Club of California, San Francisco Chamber of Commerce, University Club of San Francisco, Engineers Club of San Francisco; and an Associate Member, Faculty Club, University of California. He is a Registered Civil Engineer in California and Oregon.

How to Obtain a Paid-Up Membership

Shortly every member will receive his bill for the year 1931. One of the methods of paying this and, in fact, paying for all future similar indebtedness to the Society is a plan inaugurated some years ago providing for annuity contracts, ensuring paid-up membership. Many members have taken advantage of it. Details are listed in the 1930 Year Book, pages 42 to 44. The necessary fund to accomplish this purpose for any individual case may be found in the table shown there.

The essential feature of the arrangement is that of the agency of a third party, a reputable insurance company of long standing. The member contracts with the insurance company to handle his yearly obligations to the Society at an expense less than the sum of the several payments by virtue of the compound interest and actuarial features applicable. The company undertakes to satisfy the Society for all indebtedness until the member becomes exempt under the Constitution or until his prior decease.

Thus by a single payment, so to speak, the member is relieved of all future responsibility, and, what is perhaps as much to the point, of the yearly annoyance.

Fifty Years and More

With the passing of Thomas P. Kinsley, Member of the Society since February 1873, noted in the November issue, attention has been directed to the living men who have been associated with the Society, in any grade, for 50 years or more.

The honor of being the oldest living Member of the Society now has passed to Prof. William H. Burr, who became a Junior on June 3, 1874, and a Member in 1886. Professor Burr graduated from Rensselaer Polytechnic Institute in 1872, and returned to his alma mater to teach mechanics for nine years. After a period with the Phoenix Bridge Company, he returned to teaching at Harvard. Since 1893, in addition to his consulting practice, he has been Professor of Engineering at Columbia and Professor Emeritus since 1916. He is recognized as an authority on bridges, canals, and water supply, having served on both the first and second Isthmian Canal Commission, and is the author of many books on these subjects.

The following complete list of the 50-year men discloses the names of other well-known engineers who have served the Society, as well as the profession, with distinction:

William Hubert Burr	Jun., June 1874; Affiliate, May 1880; M., Mar. 1886
Robert Fletcher	Affiliate, Nov. 1874; M., Aug. 1909
Charles Penrose Perkins	Jun., Feb. 1875; M., Apr. 1882
Frederick Billings Howard	Jun., Mar. 1875; M., Nov. 1878
Caspar Wistar Haines	Jun., Feb. 1876; M., Oct. 1891
Henry Newton Francis	Jun., Mar. 1876; M., Nov. 1888
Charles Emery Billin	Jun., Apr. 1876; M., July 1878
Frank Ormond Whitney	Jun., May 1876; M., Jan. 1887
Charles R. Flint	F., June 1876
William Covington Gunnell	M., Feb. 1877
C. Frank Allen	M., Feb. 1878
Montgomery Meigs	M., Mar. 1879
Percival Roberts, Jr.	Affiliate, May 1879; M., June 1884
Charles Louis Strobel	M., Dec. 1879
John Garret Van Horne	M., Feb. 1880
George Herndon Pegram	Jun., Apr. 1880; M., Jan. 1883
Samuel Humphreys Yonge	M., May 1880
George Hume Simpson	M., Oct. 1880

Appointments of Society Representatives

Joseph J. Yates, M. Am. Soc. C.E., has received President Coleman's appointment as one of the Society's representatives to the Board of Trustees of the Engineering Societies Library.

Francis Lee Stuart, C. E. Grunsky, H. S. Crocker, Anson Marston, A. J. Hammond, and J. C. Hoyt, Members Am. Soc. C.E., have been reappointed Society representatives on the Assembly of American Engineering Council for a two-year term, beginning January 1, 1931.

Charles E. Smith, M. Am. Soc. C.E., has been appointed one of the Society's representatives to fill the vacancy on the Assembly of American Engineering Council caused by the death of Frank M. Williams.

M. M. O'Shaugnessy, M. Am. Soc. C.E., was appointed to represent the Society at the academic exercises of the Diamond Jubilee of St. Ignatius College of San Francisco, on October 17.

George A. Ricker, M. Am. Soc. C.E., represented the District of Columbia Section at the Conference called by the American Civic Association on November 5.

New Student Chapter Lectures

"ONE picture is worth a thousand words"—so says an old Chinese proverb, and so thought some of the Student Chapter groups who availed themselves of the lectures circulated by the Society last winter. At the beginning of the fall term of 1929, announcement was made of a new project, sponsored by the Committee on Student Chapters. This was the presentation of a series of lectures, with lantern slides, describing various famous engineering works. The material in each case was furnished by a member of the Society who had been directly connected with the construction described.

The series was started with eight titles, and in order to meet the demand it was found necessary to make up a duplicate set of each, so that 16 lectures were in circulation throughout the season. The records show that the total number of meetings at which one or another of these lectures was given was over 125. This includes several meetings held by groups other than Student Chapters. It was possible to grant such requests when they did not interfere with the student reservations.

COOLIDGE DAM, ARIZONA

There are now available 13 different lectures, 5 new ones having been added during the summer. The original series comprised the following titles: Cascade Tunnel, Conowingo Hydroelectric Development, Hetch-Hetchy Water Supply and Power Project, Flood Control in the Miami Conservancy District, Mississippi River Flood Control, Muscle Shoals Hydro-electric Development, Recent Power Development at Niagara Falls, and The Westchester County Park System.

The new lectures which have been prepared for this year include: Carquinez Strait Bridge, Catskill Water Supply of the City of New York, Coolidge Dam, Holland Tunnel, and Florianopolis Bridge.

The slides and descriptive material for any of these lectures will be reserved, on request, and sent, free of charge, to any Student Chapter. It is suggested that reservations be made early for any desired date in the school year.

Leon-Jean Chagnaud

EMINENT FRENCH ENGINEER AND HONORARY MEMBER OF THE SOCIETY

News comes of the death on July 31, 1930, of Léon-Jean Chagnaud, for many years a famous figure in engineering circles in France. This loss will be the source of sincere regret on the part of his many friends in America.

For almost 50 years M. Chagnaud has commanded an important place in the practice of French engineering. Fields too numerous to mention received his expert attention. Water works, fortifications, sanitation, tunneling both subaqueous and mountainous, subways, caissons—these and many other endeavors received an impetus under his guiding hand.

He was prominent even in the field of government, having served the State as a member of the senate and head of other administrative units. In his own profession, also, he was not without great honor; he served as President of the Société des Ingénieurs Civils de France. The government, too, laid its mark of distinction upon him when he became Officier de la Legion d'Honneur.

With all these distinctions, it would be strange if his reputation had not spread beyond the boundaries of France, and, indeed, he was widely and favorably known in many lands. The Society, too, has reason to sorrow; for in him it loses one of a distinguished company. He was elected Honorary Member June 19, 1922.

A Month of Heavy Mail

One of the most strenuous months in the history of the Society's mailing department was experienced during October of the current year. Theoretically, it should be possible to plan and distribute the labor of issuing printed matter so that no crowding occurs. This is easier to say than to do, however.

Certain routine work comes along at an even rate and is handled as it comes. In this category may be found the issues of PROCEEDINGS and CIVIL ENGINEERING. And then there are other matters which are not subject to any regularity but are bound to accumulate at certain seasons. Among these, especially during October, may be mentioned the issuing of TRANSACTIONS, reports of nominating committees for all the Divisions, the yearly bills, and finally, this year, the issuing of *Manuals 5* and *6*.

Most of these items are forwarded to all, or the majority, of the membership and thus vary up to 15,000 individual items. Then, in addition, there is the usual mail consisting of about 7,000 pieces of First Class matter, 2,000 of Third Class, and perhaps 500 pieces of Parcel Post each month.

As a result, the total consisted of 90,500 pieces handled during that month, an average of 3,620 pieces each working day. Presumably this is a record for the mailing department, the members of which are perfectly willing to admit that they would not care to make this a regular experience of more than once a year.

A Christmas Suggestion, for Ladies Especially

EXPERIENCE has shown that about this time of year a sudden increase in the number of Society badges ordered for members may be expected. Doubtless Christmas is considered a convenient time for making gifts of this suitable character. Certainly, such a custom is entirely reasonable, for the sentimental value of the Society badge makes it an ideal gift.

In ordering a new badge, it should be remembered that this can only be done as an initial order or to replace a lost emblem. This provision is because of the rule that no member may have two badges. Replacement orders should state that the pin previously owned has been lost. On the other hand, replacement of worn or damaged pins may be made by returning the old one, for which an allowance of $1.25 will be made.

This announcement is being given in good season so that no delay need be experienced in receiving the new pin on time. The trouble is not in obtaining the badges but in having the necessary engraving done. Nominally this takes about ten days, but as Christmas is a busy season for engravers, it is essential to allow a generous margin of time. In order to assure delivery well before Christmas, Society pins should be ordered without delay.

Chesapeake and Delaware Canal
Removing Sliding Banks

Rio Salado Dam and Reservoir
Don Martin Project

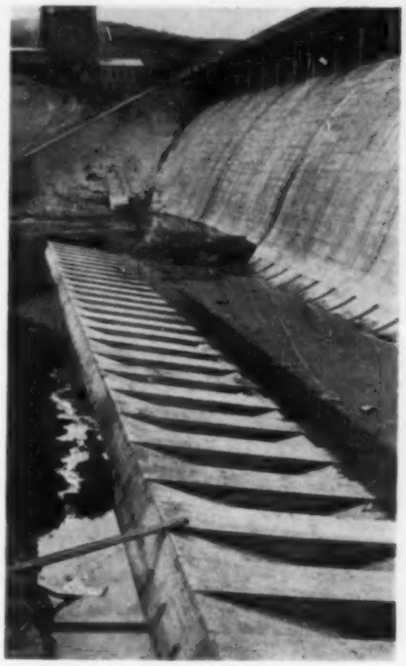
Proceedings for December Out Soon

Tidal mechanics and a detailed account of the Don Martin irrigation development in Mexico are the feature contributions scheduled to appear in Proceedings for December.

Flow in Tidal Canals

Earl I. Brown, M. Am. Soc. C.E., Colonel 8th Corps Area Engineers, Fort Sam Houston, Tex., writes on "Flow of Water in Tidal Canals." For several years he has taken a prominent part in advancing the science of tidal mechanics and the trend of his thought is nowhere more clearly demonstrated than in his contributions to the Society publications. A clear prediction of his present findings was hinted in discussion of Commander J. T. Rude's paper appearing in Vol. 92, 1928 Transactions, and in a separate paper in Proceedings for February 1928.

The present paper constitutes an unusually thorough analysis of the subject from a theoretical point of view and Colonel Brown takes the opportunity of checking his computations against field observations made in the Rehoboth, Chesapeake and Delaware, and Suez canals.



Dentate Sill and Overflow Section
Rio Salado Dam

A very satisfactory summary of studies by investigators such as Boussinesq, Bazin, Russell, Airy, Saint-Venant, Lévy, Bourdelles, Bonnet and Parsons, provides a good background for a better understanding of the newer principles involved. The paper includes a review of fundamental definitions concerning waves of translation and oscillation, in canals of finite and infinite length, connecting water bodies of finite and infinite extent.

Theoretical equations are derived which Colonel Brown shows to be in agreement with observed conditions. For instance, whereas Bourdelles and Lévy were unable to offer any satisfactory explanations of certain anomalies of velocity observed at points where canals empty into tideless seas, Colonel Brown explains it by the introduction of a reflected negative wave theory which will be the object of much discussion in the coming months.

A mere listing of article headings will be enough to convince the reader of the unusual scope and importance of this work. A few of them follow:

- Effect of Friction in Reducing the Height of a Wave in an Infinitely Long Canal
- Time Required for the Crest of a Wave to Reach a Given Point
- Influence of a Change in Width
- Interference of Two Opposed Waves
- Waves in a Canal Communicating with an Infinitely Large Reservoir
- Variation of the Tide at a Given Point
- Application of the Theory to Existing Cases

The Don Martin Project

The Federal Irrigation Law of Mexico became effective on January 4, 1926, and since that time construction work has progressed rapidly on a number of important projects. A general outline briefly describing five of them was presented in Proceedings for August 1929, by Sr. Ignacio Lopez Bancalari, Director of the National Irrigation Commission, City of Mexico. In the forthcoming issue of Proceedings, Andrew Weiss, M. Am. Soc. C.E., describes one of these projects, the Don Martin, in detail.

This project is the largest undertaken by Mexico to date under the provisions of the Irrigation Law of 1926. It is situated on the Salado River in the States of Coahuila and Neuva León. The town of Rodriquez, about 45 miles south of Laredo, Tex., is near the center of its irrigable area, which embraces a total of 160,000 acres.

A dam 41 miles upstream from Rodriquez provided 1,123,600 acre-ft. of storage, creating a reservoir covering 48,412 acres. The region is arid and most of the precipitation is in the form of torrential rains that occur from June to September. Run-off records were available from 1901, except for the years 1913 to 1922, inclusive. On the basis of these data the available supply was estimated at 670,000 acre-ft. per year. Allowing a conveyance loss of 40 per cent, the engineers estimated that this supply would provide 2.5 ft. of water over the area contemplated for irrigation.

The paper gives a valuable and detailed account of the surveys made and describes the dam with its spillway, baffles, sluice gates, and outlet works. A part of the paper that reclamation engineers will read with interest pertains to the system of land exchanges and repayment for lands.

Concerning colonization, Mr. Weiss states that President Rubio issued a resolution on May 22, 1930, which will limit colonization of the first unit of the Rio Salado System to Mexican citizens with agricultural experience, who are physically, morally, and financially capable of supporting themselves on the land during the first year.

Irrigated land may be purchased for $54.50, $52.00, or $49 per acre, depending on its desirability; and dry pasture land, for prices ranging from $1.37 to $7.50 per acre. The colonist pays 5 per cent of the cost price when he signs the contract and the remainder, with carrying charges, in 25 years.

News of Local Sections

Central Ohio Section

In place of its regular October luncheon meeting, the Section held an informal dinner meeting jointly with the Student Chap-

ter of Ohio State University, at Pomerene Hall, Columbus, Ohio, October 8, 1930. The guests of honor were President Coleman and Allen P. Richmond, of the Secretary's staff. Mr. Coleman gave an address on Engineering in New Orleans, and Mr. Richmond spoke on Society matters. All business was postponed until the next meeting.

Cincinnati Section

J. E. Root, President of the Cincinnati Section, presided at a meeting of the Section held on October 9, 1930, and gave a report of the fall meeting of the Society, held at St. Louis, October 1 to 4. Major John Berry, Manager of the Cleveland Airport, who was to have given the principal address was unable to be present, so H. W. Hanly introduced Alfred Wunder, Superintendent of the Municipal Airport, and Herbert Starick, President of the Student Chapter of the University of Cincinnati, as the chief speakers of the evening. Others who spoke were: Major Bradley Jones, Professor of Aeronautical Engineering at the University of Cincinnati; George P. Stowitts and J. M. Belknap, of the Cincinnati Union Terminal Company; E. D. Gilman and C. S. Trimanns. The attendance was 28.

The next meeting of the Section is to be held jointly with the Student Chapter at the University, January 9, 1931. The feature of the occasion will be an address by City Manager C. A. Dykstra on "The Los Angeles Waterworks."

Duluth Section

The Section held its regular luncheon meeting on September 15 at the Kitchie Gammi Club. Talks were given by C. R. Smyth, of the Layne Bowler Company, and by Rodney Payne, Superintendent of the Duluth parks. The latter described the extensive duties of the park department in the administration of parks, boulevards, playgrounds, golf courses, and zoos. The attendance was 18.

On October 20 the meeting was devoted to a description of the fall meeting of the Society at St. Louis. The report was given by William C. Hawley, Secretary of the Duluth Section, who enjoyed the hospitality provided by the St. Louis Section. The attendance numbered 15.

The engineering profession was recently advertised in Duluth as a result of the fact that the delegates of the Sixth International Road Congress on their visit to Duluth on October 16 were entertained by President S. B. Shepard and Vice-President Gordon Butler, of the Section, who were serving on the Engineer's Club reception committee.

Georgia Section

The October meeting of the Georgia Section was delayed until October 16 in order that it might be combined with entertainment for J. F. Coleman, President of the Society. A luncheon meeting, presided over by W. A. Hansell, President of the Section, was held, and the 30 members present were addressed by Mr. Coleman and by Allen P. Richmond, Assistant to the Society's Secretary.

An informal dinner meeting and smoker was held at the Athletic Club at 7:00 P.M. of the same day in honor of President Coleman and Mr. Richmond. The meeting, at which 50 members and guests were present, was called to order by President Hansell.

After dinner Mr. Coleman addressed the meeting on the subject, "My Most Interesting Job," in which he described in detail the planning, construction, and supervision of the Chickasaw Shipbuilding Company at Mobile, Ala., during the War. Mr. Coleman was General Superintendent in charge of the entire job, and his remarks presented a vivid picture of the varied duties a civil engineer is called upon to handle aside from his professional work.

Upon conclusion of his address, J. T. Moore, of the American Steel and Wire Company, introduced T. F. Peterson, of the same organization, who explained the construction and installation of a power cable across San Francisco Bay, a distance of about seven miles. A splendid film, illustrating the details of preparing and joining the cable sections and also of laying the cable, accompanied his talk.

A short discussion followed and the meeting adjourned at 10:00 P.M. The entire program was thoroughly enjoyed by all present, and the Georgia Section was delighted to have an opportunity to meet and know two such members as Mr. Coleman and Mr. Richmond.

Louisiana Section

The work of the Louisiana Section in establishing an engineering scholarship in Tulane University, New Orleans, was recently commended by A. B. Dinwiddie, President of the University, in a letter to E. S. Lanphier, President of the Section. Mr. Dinwiddie commented on the fact that the scholarship not only fosters a connection between the Tulane College of Engineering and the Society, but also rewards deserving students in the most practical way possible.

New Mexico Section

At the first fall meeting of the Section, held at Albuquerque, October 15, 1930, J. H. Dorroh, head of the Department of Civil Engineering of the University of New Mexico, spoke on the subject of "Registration of Engineers."

W. B. Ream, Designing Engineer of the Middle Rio Grande Conservancy District, was elected Secretary and Treasurer for the ensuing year to fill out the uncompleted term of A. Diefendorf who has become Professor of Civil Engineering at the University of Pittsburgh.

Northwestern Section

A week in Moscow, thence through the coal and iron ore fields of the Donetz Basin and Ukraine; across the desert of southeastern Russia, north and east along the Kirgiz Steppes; thence across the Urals and back to Moscow; then once again across Russia and on through the great expanse of Siberia to Vladivostock. Such was the remarkable 17,000-mile trip recently completed by Ralph Budd, of the Northwestern Section, and a small group of engineers for the purpose of inspecting the railroads of Russia for the Soviet Government.

Mr. Budd described his trip at a dinner meeting of the Section held in the Minneapolis Athletic Club on October 3. Some of the interesting matters that he touched upon were the freight terminals and rectangular engine houses, the types of equipment for freight and passenger traffic, methods of control and signalling, and the hook and chain couplers of freight cars. In eastern Siberia, it was found that the Trans-Siberian Railway traverses 1,200 miles of ground that is perpetually frozen to a depth of many hundreds of feet.

H. D. Lovering presided at the meeting, which was attended by 60 members and guests. During the business session the following new officers were elected: William N. Carey, President; George E. Loughland, Vice-President; M. W. Hewett, 2nd Vice-President; H. M. Hill, Secretary and Treasurer.

The regular meeting of the Section was held October 20, 1930, with 90 members and their guests in attendance. President Woodbury, after touching briefly upon some local engineering problems, introduced the speaker of the evening, R. H. Lasche, Chicago Manager of the Fairchild Aerial Surveys Company. Mr. Lasche illustrated his interesting lecture with stereopticon slides showing camera operations, methods of plotting, and similar details of aerial photography.

Philadelphia Section

The first of the 1930–1931 series of meetings of the Section was held at the Engineers' Club, October 16, 1930, at 7 P.M. The meeting was preceded by a dinner at the Club.

W. F. Carson, of Carson and Carson, a member of the Section, gave an interesting address on "Steel Welding," with particular reference to the welding of steel frame buildings in Atlantic City, N.J., Boston, Mass., and Dallas, Texas, with which he has had recent experience. Other addresses were given by F. N. Smith, Consulting and Industrial Engineer of Philadelphia, who spoke on the various alloys of steel; and B. F. Hastings, District Engineer, American Institute of Steel Construction, and member of the Section, who described the development of the use of structural steel for building purposes and showed interesting moving pictures of the construction of the Bank of Manhattan Building, New York City.

Attendance at the dinner numbered 70, and at the meeting 125.

Los Angeles Section

The local sections of the four Founder Societies met in joint session at the Engineer's Club on November 12 to hear F. E. Weymouth, Chief Engineer of the Metropolitan Water District, deliver an illustrated paper on the vital subject of "Bringing Colo-

rado River Water to Los Angeles." Mr. Weymouth told of the depletion of the water supply of the South Coastal Plains, and the organization of the Metropolitan Water District to secure an additional supply. He then described four proposed routes for an aqueduct to convey water from the Colorado River to the district, telling of the obstacles to be overcome in construction and the economics of the various plans.

An indication of the interest in this important subject is shown by the attendance of 430 members of the four Societies and their guests. President Barnard, of the Section, presided and introduced the local officers of the Electrical, Mechanical, and Mining groups. At the Junior Forum, preceding the main session, Donald Barnes and H. W. Goodhue showed a series of lantern slides of the Hoover Dam site and the Colorado River.

On October 29 the Sanitary Group of the Section presented a program on "Conservation." F. S. C. Hemig, of the Rendering and Reduction Corporation, read a paper on "Reclaiming Refuse," which pointed out the enormous amount of waste material that is thrown away or disposed of, and stated that this could be reclaimed and converted into useful products at a profit on a commercial scale.

W. S. Rosecrans, President, Los Angeles County Conservation Association, presented a paper outlining the work of the Association in developing a comprehensive program for flood control, water conservation, and water-shed protection in Southern California.

A paper on "Flood-Water Spreading in Southern California," prepared by A. T. Mitchelson, Senior Irrigation Engineer, U.S. Department of Agriculture, was read by H. F. Blaney. This article described water spreading as it is practiced by several agencies in this vicinity, also the U.S. Department of Agriculture's experimental work to determine the rate of percolation, effect of vegetation, and effect on the water table.

A paper on "General Consideration of Sewage Reclamation from a Sanitary Standpoint" was presented by E. A. Reinke, Assistant Engineer, Bureau of Engineering, State Department of Health.

San Francisco Section

The regular meeting of the San Francisco Section, held at the Engineers' Club, August 19, 1930, boasted an attendance of 105, while 95 were at the dinner preceding it.

President Dewell, who was in charge of the meeting, announced that the Section had lost a valued member in the death of Mr. John C. Wilson and asked those present to pay a tribute of several moments' silence to the memory of Mr. Wilson. Statements were then made by the chairmen of various committees, including the report of the Membership Committee to the effect that, since the June meeting, the Section has gained nine new members. This makes the total membership of the Section 562.

The feature of the evening was an address by Professor B. M. Woods, Chairman of the Department of Mechanical Engineering at the University of California, on the subject, "How Rapidly Is Air Transportation Coming?" Professor Woods illustrated his remarks with numerous lantern slides.

The customary social event of the Section's annual calendar was this year designated a "convention," because ladies were in attendance, because excellent golf facilities were provided, and because the section was intensely convention-minded following the Spring Meeting of the Society at Sacramento last April. The date, September 20, was selected to avoid conflict with late vacations and early football games and to give reasonable assurance of good weather for the outdoor events. The place was the very recently completed clubhouse of the Union League Golf and Country Club, located near San Bruno, about 18 miles south of the San Francisco Ferry Building.

All members of the Section were urged to attend and to bring ladies and other guests. In addition, special invitations were sent to the Sacramento and Los Angeles Sections and to the Student Chapters of the University of California and Stanford University, and the result was an attendance of 137.

The program consisted of golf and tennis tournaments for men, and bridge for ladies in the afternoon; a banquet and short convention program in the evening, followed by dancing and bridge.

Seattle Section

Since the Society at its Sacramento meeting on April 21, 1930, approved the action of the Western Washington Section in its balloting to change its name, the Section will hereafter be known as the Seattle Section.

A special dinner meeting of the Section was held at the Engineers' Club, August 7, 1930, in order that the members might have the opportunity of hearing Dr. Elwood Mead, U. S. Commissioner of Reclamation, and R. F. Walter, Chief Engineer, Bureau of Reclamation. Dr. Mead spoke on the Columbia River Basin project and described the work of the Reclamation Service, which proved of interest to all. Chief Engineer Walter described the methods of construction.

Among those present were Governor Hartley and various members of the State Chamber of Commerce. The attendance was 74.

On August 26, 1930, the Section gave a luncheon at the Engineers' Club in honor of Joseph B. Lippincott, Consulting Engineer at Los Angeles, who addressed the section, his subject being "Water Supply in California."

The regular monthly meeting of the Seattle Section was held at the Engineers' Club, September 30, 1930.

Following dinner, Major Joseph Jacobs gave an interesting account of the Cleveland meeting. He also stated that several colleges waive initiation fees and the first-year dues in the case of student members and suggested that the Seattle Section offer annual prizes to the Student Chapter of the University of Washington. A motion to the effect that the Section should offer two annual prizes to the Student Chapter of the University of Washington was then made and carried. The basis of award and the nature of the prizes are to be recommended by the contact man of the Student Chapter and Dean Tyler, of the College of Engineering, University of Washington, at the next meeting.

J. L. Stannard, President of the Tacoma Section, presented the Seattle Section with a gavel made from wood found in excavating the tunnel at Cushman Dam site. It is estimated that this wood is more than 25,000 years old. The gavel was presented to the Section as a token of appreciation for its cooperation and work in establishing Tacoma as the site of the 1931 Convention. Mr. Stannard then extended an invitation that was greatly appreciated to members of the Seattle Section to visit the Cushman Hydro-electric Project.

The attendance numbered 20.

Texas Section

Many interesting features characterized the annual meeting of the Texas Section, which occurred at Houston, October 24 and 25, 1930. The program on the first day included addresses by James E. Pirie, of Albany; E. C. Woodward, Division Engineer, of the State Highway Department; and Gibb Gilchrist, State Highway Engineer of Texas. After a luncheon, at which the visiting ladies were entertained, the meeting was addressed by Dr. Donald C. Barton, Consulting Geologist, of Houston, and by Capt. Arthur W. Parker, Quartermaster Corps, U. S. Army. The latter described the development and construction features of Randolph Field, known as the "West Point of the Air." Later in the afternoon the members were taken on a boat trip down the Houston Ship Channel to the San Jacinto battlegrounds.

On Saturday morning, G. L. Fugate, Principal Assistant City Engineer of Houston, read a paper entitled, "Studies of Gulf Coast Storms and Floods." Following this address, the Section had a business session for the purpose of hearing the reports of the various committees and electing officers for the new year. The election resulted as follows: O. H. Koch, President; T. E. Huffman, 1st Vice-President; E. P. Arneson, 2nd Vice-President; J. T. L. McNew, Secretary-Treasurer.

Student Chapter News

Leon D. Conkling, Professor of Civil Engineering at Montana State College, has sent word to the Society of the election of the following officers in the College Student Chapter: President, Joseph Sonntag, of Bozeman, Montana; Secretary, Harold M. Hanson, of Bozeman.

The Student Chapter of Massachusetts Institute of Technology recently had the pleasure of hearing an address by Arthur Tyndall, Highway Engineer of Wellington, New Zealand. Mr. Tyndall's visit to this country was for the purpose of attending the International Road Congress.

ITEMS OF INTEREST

Engineering Events in Brief

James Laurie and the Formation of the Society

THE RESEARCH and careful compilation of data by Charles Warren Hunt, Secretary Emeritus, published by the Society in 1897 as a *Historical Sketch of the American Society of Civil Engineers*, makes it possible to obtain a perspective of the Society's first President, James Laurie, whose picture appears in this issue.

The earliest effort to form an association of the civil engineers of America was started by a call from a meeting of the profession held in Augusta, Ga. The appeal resulted in a "convention of civil engineers of the United States," held at Barnum's Hotel, Baltimore, on February 11, 1839. Forty gentlemen from Georgia, Illinois, Louisiana, Maryland, Massachusetts, Missouri, New York, New Jersey, North Carolina, Pennsylvania, and Virginia were present. Organization plans were considered and a constitution proposed, but the proposals failed of acceptance.

This was in 1839. In 1852 another effort, this time originating in New York City, resulted in the ultimate formation of the American Society of Civil Engineers, although not without difficulties and delays.

Six New York engineers, William H. Morell, J. W. Adams, James Laurie, William H. Sidell, Alfred W. Craven, and James B. Kirkwood invited those interested in the formation of a Society of Civil Engineers and Architects to meet on November 5, 1852, in the office of Mr. Craven, Chief Engineer of the Croton Aqueduct Department, Rotunda Park. The office was located in what is now City Hall Park, facing Chambers Street, near Centre Street. With Mr. Craven in the chair, Messrs., Laurie, Adams, and Sidell were appointed to prepare a draft of a constitution and by-laws. After a short retirement the Constitutional Committee presented its draft, which was taken up section by section, discussed, amended, and adopted, and this constitution remained in operation without change until 1868. The following officers were elected:

James Laurie, President
Edward Gardiner and Charles W. Copeland, Vice-Presidents
William H. Morell, William H. Sidell J. W. Adams, J. P. Kirkwood, and A. W. Craven, Directors
Robert B. Gorsuch, Secretary-Treasurer

Others of the 14 present at the first meeting were, Thomas A. Emmett, J. W. Ayres, of New York, G. S. Greene, of Albany; S. S. Post of Owego; and W. H. Talcott of New Jersey.

Ten other gentlemen accepted membership, and at the meeting held on December 1, 1852, the proposed by-laws were read, discussed, amended, and adopted. On January 5, 1853, was held the first technical meeting, and it is a matter of interest that even at that early date the topic of the evening was "The Relief of Broadway," by President Laurie. He submitted plans for placing railway tracks above the level of the street, this probably being the forerunner of the present elevated systems.

By the end of the year 1853 the membership had grown until there were 6 Honorary Members, 1 Corresponding Member, and 48 Members. The treasury boasted of $585. In the first list of members is noted the name of Theodore D. Judah, the famous railroad engineer who was honored during the Spring Meeting in Sacramento this year, when a monument to his accomplishments and memory was unveiled there. Listed also are the names of James B. Francis, John A. Roebling, William H. Talcott, and others whose works and reputation were even then well known to the profession.

But during the next 15 years the interval between meetings became longer and longer. Twelve and a half years elapsed after the meeting of March 2, 1855 until, pursuant to the call of President Laurie, a special meeting was called on October 2, 1867, "to take such steps as might be necessary to resuscitate the Society."

The resolution passed at that meeting is one which each of the 14,500 present members of the Society could endorse, for, as James B. Kirkwood, elected the Society's second president at that meeting, stated in his annual address, "The organization of the Society is mainly due to the persevering efforts of Mr. Laurie."

SOCIETY RESOLUTION OCTOBER 2, 1867

RESOLVED, THAT *we tender our thanks to Mr. James Laurie for his faithful services as our President, for his efforts to reestablish and reorganize this Society on a basis which gives promise of a successful and useful continuance, and particularly for his care of our funds, to which we are greatly indebted for our present unencumbered and hopeful condition.*

French Highway Engineers Entertained

FOLLOWING the International Road Congress held in Washington in early October, the delegates from foreign countries were taken on tours about various sections of the United States to see work in progress or completed. After these tours, many of the engineers returned to New York to await their sailing dates.

On Monday, October 27, a party of French engineers arrived in the city. Advance information of their coming had been received through the District Office of the Bureau of Public Roads so that a prepared itinerary for Monday and Tuesday was awaiting their arrival.

On Monday afternoon they inspected the Fort Lee end of the Hudson River Bridge, through the courtesy of the Port of New York Authority. On Tuesday morning the City of New York donated the use of the S. S. *Riverside* for a harbor trip to the Kill van Kull Bridge connecting Staten Island with New Jersey, and subsequently up the East River to see the Brooklyn, Manhattan, and Williamsburg bridges. On this harbor voyage, the party was joined by four English Engineers and both groups were accompanied by two members of the staff from the Port of New York Authority, who answered questions and explained the points of interest.

On Tuesday afternoon, the French group was taken, through the courtesy of the Arthur McMullen Company, to inspect the West Side Elevated Highway of New York, and the New Jersey Elevated Highway Viaduct, now under construction across the Hackensack River. The Holland Tunnel Commission granted the courtesy of the Tunnel to the group and provided escort.

The party was accompanied on the New Jersey side by H. W. Hudson, M. Am. Soc C.E., and other engineers from the New Jersey State Highway Department. Officers of the Arthur McMullen Company provided every facility for the inspection of their caisson and pier work for the New Jersey Elevated Highway. Upon returning to New York, the party inspected the control room of the Hudson River Tunnel.

According to several of the visitors,

these trips to them marked a fitting climax to an altogether enjoyable stay in the United States.

Progress in Registration of Engineers

THE National Council of State Boards of Engineering Examiners opened its Eleventh Annual Convention at Richmond, October 20, 1930. T. Keith Legaré, M. Am. Soc. C.E., Chairman of the Society's Committee on Registration of Engineers, was elected President. Other officers elected were D. B. Steinman, M. Am. Soc. C.E., Vice-President; and P. H. Daggett, Dean of Engineering at Rutgers University, Secretary and Treasurer.

Two important committees were appointed, all the members of which, with one exception, are members of the American Society of Civil Engineers. The committee to draft a new system of reciprocity in connection with the registration of engineers consists of L. M. Martin of Iowa, M. Am. Soc. C.E., Chairman; C. T. Olmsted of Michigan; and N. W. Dougherty, M. Am. Soc. C.E., of Tennessee.

The committee to investigate and compile uniform examinations to be used by the various State boards for registration of engineers is made up of D. B. Steinman, M. Am. Soc. C.E., of New York, Chairman; Donald M. Baker, M. Am,. Soc. C.E., of California; and J. S. Dodds, M. Am. Soc. C.E., of Iowa.

These committees will report at the convention next year at Detroit.

A.S.M.E. Elects New Officers

RESULTS of the election of officers of the American Society of Mechanical Engineers for 1931 was announced by the tellers of election on September 23, 1930, after canvassing the ballot of the membership. The new officers of the society are as follows:

President, Roy V. Wright, Managing Editor, Railway Age, New York.

Vice-Presidents, William A. Hanley, Chief Engineer, Eli Lilly Company, Indianapolis; Thomas R. Weymouth, President, Oklahoma Natural Gas Corp., Tulsa, Okla.; and Harvey N. Davis, President, Stevens Institute of Technology, Hoboken, N.J.

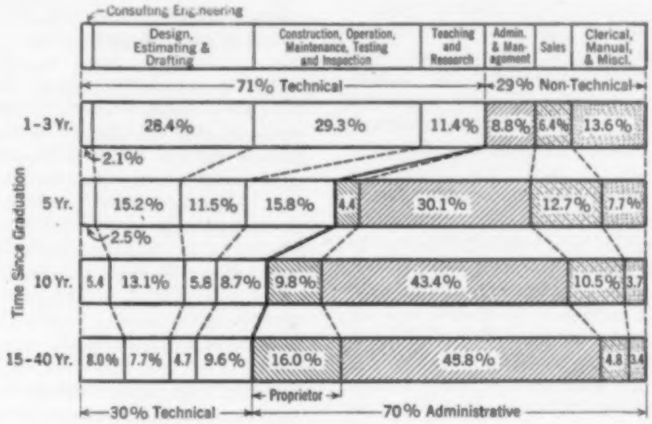
Managers, W. L. Batt, President, S K F Industries, Inc., New York; H. L. Doolittle, Chief Designing Engineer, Southern California Edison Co., Los Angeles; and H. L. Whittemore, Chief of Engineering, Mechanics Section, Bureau of Standards, Washington, D.C.

Representatives to the American Engineering Council, W. R. Webster, Bridgeport, Conn.; R. V. Wright, New York; J. W. Roe, New York; Robert Yarnall, Philadelphia; E. N. Trump, Syracuse, N.Y.; B. E. Hull, Houston, Tex.; E. O. Eastwood, Seattle, Wash.; W. Trinks, Pittsburgh; Warner Seely, Cleveland; and William S. Conant, Washington, D.C.

Technical *vs.* Administrative Duties

NOT so long ago an interesting study covering many practical phases of engineering employment was completed. Although it was undertaken by, and was largely for the use of, teachers of engineering, through the Society for the Promotion of Engineering Education, it has implications of interest to all engineers.

newly graduated engineer is largely forced to enter the strictly scientific fields of his profession, or perhaps he is anxious to put his theories into practice immediately. In any event and whatever the motive, about 7 out of every 10 graduates immediately find themselves in technical employment, and only 3 in administrative or similar work; but not for long. Progressively the technical fields lose their men to the administrative. After about 10 years this trend becomes somewhat stabilized, and soon the proportions are almost exactly reversed. The averages are still 7 to 3 but the popular field is now administrative.



PROGRESSIVE TREND OF ENGINEERING GRADUATES TOWARD EXECUTIVE DUTIES

One phase of this study had to do with the varying functional classification of employment throughout the average engineer's life. The chart here reproduced from Bulletin 3, the result of the investigation of engineering education by the Society for the Promotion of Engineering Education, indicates the average experience of about 7,000 men whose length of practice at the time the study was made, 1925–1926, varied from 1 to 40 years.

Assuming that this experience is representative, many changes may be expected as the average engineer grows older. For example, if he starts out in professional or construction work it is about a 6 to 1 chance that he will find himself in some other line after 15 years or more.

Perhaps the most remarkable tendency revealed by the study will be found by dividing the classes of work into two broad generalizations, which for convenience have been denominated "technical" and "administrative." Quite evidently the

As applied to teaching, for which these data were prepared, the inferences are clear. If what students may eventually become is known, the training can be planned accordingly. The implications to the engineering practitioner, however, are not so clear. Agreeing that the statistics are fairly representative, the main question is whether the definite trend is desirable or whether emphasis on administration in preference to technic is wise. A question that naturally arises is this—is not a strictly scientific course a mistake to 7 out of every 10 students, who can definitely expect that they may soon be stressing other phases of engineering experience?

Geological Survey Releases 20 Chicago Quadrangles

CHICAGO and the adjacent suburban territory have been mapped by the U.S. Geological Survey, Department of the Interior, and 20 quadrangle sheets are just now available at the usual price of 10 cents each. The work has been done to a scale of 1 in.-2,000 ft., with 5-ft. contours, and the standard of accuracy is the highest that present-day mapping methods have made possible. Such details as bunkers on the golf links (miniature courses excepted), detached buildings, switches, and spin tracks in railroad yards, and the "kettle holes" of glacial maraines are all shown in unusual completeness. Closed instrumental surveys of the area were supplemented by large numbers of airplane photographs taken on systematically planned flights.

The separate sheets each cover $7^1/_2'$ of both latitude and longitude, an area of over 50 sq. miles. If assembled on one sheet, the 20 new quadrangles will make a map 5 ft. 8 in. wide by 11 ft. 4 in. high.

Still in Print

THE Society has printed a 48-page list of the 1,447 papers and discussions which are available in pamphlet form. Beginning with the first publication in 1868, there have been issued 1,721 papers, of which 84 per cent are thus seen to be still in print.

The list shows the serial number, title, author, and price of each paper, and a table gives the approximate year of publication.

It may come as a surprise to the reader that Paper No. 1 is still in print, the "Description of a Line of Large Water-Mains Laid by the Croton Aqueduct Department of the City of New York," by A. W. Craven, presented in January, 1868.

No. 1A, an address by President James B. Kirkwood, No. 2, "Blasting with Nitro-Glycerin," by Edward P. North, and No. 3, "Corrosion of Iron," by William J. McAlpine, are also listed.

The first omission is Paper No 4, "Durability of Cast-Iron Water-Mains," by James B. Francis. The next blank is for No. 16, "Experiments for Making Brick Masonry Impervious to Water," by W. L. Dearborn.

Turning to the other end of the list, the highest numbered paper out of print is No. 1,598, "Moments in Restrained and Continuous Beams by the Method of Conjugate Points," by Nishkian and Steinman, while the next previous one is No. 1,568, "Design of Symmetrical Concrete Arches," by Charles S. Whitney.

Copies of the list may be obtained upon request from the Secretary's office.

Development of Mississippi River Flood Control

AT ITS October meeting, the Board of the American Engineering Council took up again the important topic of Mississippi flood control. After listening to a report of its Flood Control Committee, it adopted the following resolution:

"*Be it Resolved by the Administrative Board of American Engineering Council,* that this body adheres to the opinion heretofore expressed that so much is involved in the Mississippi River flood control project, that before final commitment to the major engineering features of the project is made, the Chief of Engineers of the Army should have the benefit of the counsel of the best hydraulic engineering talent that the Nation affords. In its judgment, some of the present expenditures, even though warranted as partial protection, may not be effective in the plan finally adopted."

It was reported that surveys and studies are now being made under the Chief of Engineers more nearly commensurate with the importance of the subject than those previously attempted. Because of the importance of such studies, it was urged that Congress allow ample time for the Chief of Engineers to perfect his preliminaries before committing himself to the general plan of flood relief.

In doing so, the Board of Engineering Council further emphasized the fact that there are not only engineering problems to be solved, but also economic problems. Investigation may show that the value of some tracts of land does not justify large expenditures for flood protection but that such lands should be taken over for re-forestation under existing Federal laws.

Japanese Seismographer to Lecture

AMERICAN ENGINEERS are to have the privilege of hearing one of the greatest students of seismology in the world in the person of Prof. K. Suyehiro, the Director of the Earthquake Research Institute at the Tokyo Imperial University of Japan. In response to an official invitation extended by the Society last April, word has been received that the noted engineer expects to spend several weeks in this country next spring.

A large measure of the success in securing Professor Suyehiro is due to the efforts of Past-President John R. Freeman, who supplemented his intense interest in the subject of earthquakes with a personal acquaintance with and friendship for this noted Japanese investigator. Professor Suyehiro's health was an obstacle to the proposed visit but fortunately this objection has now resolved itself, and he finds that early in 1931 it will be possible for him to undertake this trip.

His schedule in America, involving a series of lectures at each of several points throughout the country, will be announced in due course.

COMING EVENTS

AMERICAN SOCIETY OF CIVIL ENGINEERS
Annual Meeting Convenes in New York
January 21, 22, 23, 1931

NATIONAL RESEARCH COUNCIL
Results of research work will be presented at the Highway Research Board Meeting, Washington, D.C., December 11–12, 1930.

GEOLOGICAL SOCIETY OF AMERICA
Will meet at Atlantic City, December 29–31.

AMERICAN ROAD BUILDERS ASSOCIATION
The annual convention and road show will be held in St. Louis, January 12 to 16, 1931.

TWENTY-THIRD ENGINEERS
A reunion will be held in New York soon. Before the exact date is determined, members of the regiment are urged to send their addresses to Doane Eaton, 50 Morningside Drive, New York.

International Standards Association Conference

OF INTEREST to all engineers is the standardization of equipment—methods, analyses, tests, nomenclature, sizes, and shapes. As described in our *Year Book*, the American Standards Association has as its objects:

"To provide systematic means of co-operation in establishing American Standards to the end that duplication of work and the promulgation of conflicting standards may be avoided; to serve as a clearing house for information on standardization work in the United States and foreign countries; to act as the authoritative American channel in international co-operation in standardization work."

The membership of this association is composed of 14 national technical societies, including the American Society of Civil Engineers; 11 manufacturing associations; numerous fire, casualty, and surety associations; and 7 governmental departments.

Under the auspices of the International Standards Association, 18 countries joined together and sent delegates to a two-day conference held in Paris during May, 1930. The purpose of this Annual Conference was to discuss means of accomplishing world-wide standardization. Among the subjects discussed were paper sizes for books, pamphlets, letterheads, and business forms. A standard generally used in Europe makes the dimensions of paper in the ratio $1:\sqrt{2}$. Another subject was that of the use of national standards in technical drawings to simplify drafting-room practice.

Of interest also was the proposal for an international standard test pressure for the acceptance of new stationary boilers. A proposal was made to test at a pressure in pounds per square inch equal to 1.3 times the working pressure plus 43. The subject of rivet and bolt sizes was considered at length without reaching a conclusion. Traffic signals for an internationally acceptable standard were presented but not adopted. A committee is to be appointed at an early date to determine methods of standardization of the measurement of fluids through nozzles and orifices.

Exhaustive Study of 1927 New England Flood

IN THE fall of 1927, New England was subjected to a rainfall of unusual magnitude, amounting in various places to a total of 8 or 9 in. over a period of four days. Coming as this did on top of a saturated soil condition, it resulted in floods of unprecedented intensity. While these were confined in large part to the Connecticut and Champlain valleys, the effects were felt elsewhere throughout the New England States.

Realizing that some responsibility for analyzing these conditions from a scientific standpoint devolves upon the profession, the Boston Society of Engineers, in No-

vember, 1927, two weeks after the flood, through its Board of Government authorized the appointment of a committee to make an exhaustive study of the unusual event which had caused these flood catastrophies, particularly in Vermont. The report of this committee, now issued, presents an imposing volume—imposing not only in the mass of material collected but in the variety and depth of study it portrays.

After a thorough review of the history of the 1927 and previous great storms, the committee has dealt extensively with flood factors and flood formulas for the New England District, and finally with flood characteristics and flood prevention measures.

Augmenting the report, appear 36 diagrams and 32 tables, some of the latter showing the result of extensive and intensive study. All in all, this report of 180 pages should constitute a most interesting volume of information and reference to every hydraulic engineer. Copies of the special issue of the Society's journal containing the report are obtainable from the Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass., at $1.00 per copy. Arthur T. Safford, M. Am. Soc. C.E., was Chairman of its Committee on Floods, and S. S. Kent, was Secretary.

Are You Interested in Research?

A REVISION of *Industrial Research Laboratories of the United States, Including Consulting Research Laboratories,* the third edition of which was published in 1927, is being prepared by the Research Information Service of the National Research Council.

This bulletin, which contains the only list of research laboratories known to the compilers, is undoubtedly used by many people, not only as a source of information concerning such laboratories but also as a mailing list for important announcements concerning new apparatus and processes, and for compilations of interest to research workers in industrial fields.

In spite of an extensive search for names and addresses of interested organizations, it is felt that many organizations maintaining research laboratories have been overlooked. Since the value of such a compilation is in direct proportion to its completeness, it is hoped that everyone interested will cooperate in this undertaking.

If, therefore, your company is not one of the 2,250 to which a questionnaire has been sent, will you please write immediately to the Research Information Service, National Research Council, Washington, D.C., for a questionnaire, in order that proper information may be secured regarding the personnel and research work of your laboratory. This listing involves no financial obligation on the part of the correspondent and may be of considerable value at some time in the future.

Engineering Foundation Inc. and Engineering Education

More than 50 representative engineering executives and educators met on October 16, 1930, at the request of the Engineering Foundation Research Board to discuss problems of engineering education.

The main topics discussed were: (1) methods by which such aptitudes, abilities, and interests as are necessary for success in engineering pursuits might be detected in prospective engineering students; (2) a differentiation in education and training of youths capable of becoming professional engineers or of utilizing technical abilities as chief executives from those who should be draftsmen or instrumentmen, or who should choose other sub-professional vocations; and (3) means of informing promising young men about engineering, and of directing them toward the profession, or to an engineering education as a preparation for certain other pursuits.

An Educational Research Committee was appointed, composed of the following members:

Harvey N. Davis, Chairman, President, Stevens Institute of Technology; representing The American Society of Mechanical Engineers.

George W. Kittredge, Railroad Engineer, formerly Chief Engineer of the New York Central Railroad; representing the American Society of Civil Engineers (former Vice-President).

William B. Plank, Head of Mining Department, Lafayette College, Easton, Pa.; representing the American Institute of Mining and Metallurgical Engineers (Chairman of Committee on Engineering Education).

Harold B. Smith, Head of Electrical Engineering Department, Worcester Polytechnic Institute, Worcester, Mass.; representing the American Institute of Electrical Engineers (President last year).

R. I. Rees, Assistant Vice-President, American Telephone and Telegraph Company, New York; representing the Society for Promotion of Engineering Education (President last year).

Alfred H. White, Professor of Chemical Engineering, University of Michigan, Ann Arbor; representing the American Institute of Chemical Engineers (President).

Alexander R. Stevenson, Jr., Engineer, General Electric Company, Schenectady, New York; designated by Engineering Foundation.

The Committee had its first meeting on November 7, and has already begun its work. Among the subjects which have been assigned to individual members, to be studied and reported on are: (1) placement of students in engineering colleges; (2) objective tests; (3) placement of engineering graduates in industry; (4) adjustment of students and graduates to their environment; (5) extension of the public's knowledge of engineers and their work; (6) the selection of other worthwhile subjects, not being studied by other bodies, which the Committee should investigate.

New Edition of "Who's Who in Engineering"

IN ANTICIPATION of a new edition of *Who's Who in Engineering* for 1931, questionnaires have recently been sent out to a number of engineers who may be eligible for inclusion. As in the previous editions, great care is being taken to insure that the sketches are accurate and up-to-date.

Among other requirements, it is being demanded that the engineers whose names appear shall have had an experience at least equivalent to that of the grade of Member in the Society. Under this limitation it is hoped to include 20,000 biographical sketches.

In the few years of its existence, this publication has found for itself a useful place in engineering. At Headquarters it is in constant use for reference and has earned a reputation for reliability. The American Engineering Council is active in the promotion of the new edition, working through a capable committee having wide contacts. This committee expresses the desire that every Member of the American Society of Civil Engineers will cooperate in order that the 1931 edition of *Who's Who in Engineering* may maintain the high standard of its predecessors.

Demand for Translations of "TRANSACTIONS"

FROM TIME TO TIME evidence is received at Headquarters of the high esteem in which papers published in PROCEEDINGS and TRANSACTIONS are held. Often this manifests itself in the form of a request for permission to translate certain papers or reports into foreign languages.

The latest of these translations is that of Paper No. 1598, TRANSACTIONS, 1927, "Moments in Restrained and Continuous Beams by the Method of Conjugate Points," by L. H. Nishkian and D. B. Steinman, Members Am. Soc. C.E. This was translated into Polish by Dr. Karol Pomianowski, of the Warsaw Polytechnic Institute. It is interesting to note that all the diagrams had to be re-drawn and the dimensions and notations changed to metric units and Polish nomenclature, and that two of the tables were recalculated.

This brings to mind the fact that in 1924 a Spanish translation of the Society's Bridge Specification was published in the Spanish edition of the general catalogue of the United States Steel Products Company. Here, also, all tables and formulas were recalculated into the metric system.

It has been the usual policy of the Society to grant permission for such translations upon request, provided that proper credit is given to the Society's publications, and that the full title of the paper, the name of the author, the year of publication, and page number are clearly shown.

Novel Honor for John F. Stevens

THE GREAT NORTHERN Railroad has selected for designating its fine Pullman cars the names of men who have played an important part in the development of the Northwest. Five cars have been named for men now living, among them being the "Stevens," named for John F. Stevens, Past-President, Am. Soc. C.E., formerly Chief Engineer of the Great Northern Railroad and of the Panama Canal. This moving monument is operated on the railroad's crack train, the Empire Builder.

NEWS OF ENGINEERS

O. H. AMMANN, constructor of the Hudson River Bridge, the largest in the world, has received the degree of Doctor Honoris Causa from the Federal Polytechnicum at Zurich.

NEIL VAN EENAM, formerly Structural Engineer, with the Allied Engineers, Inc., Jackson, Mich., has become Bridge Designer for the State Highway Department of Lansing, Mich.

EDMUND W. BOWDEN has become Assistant to the Chief Engineer, Port of New York Authority. Prior to that he was Junior and Assistant Engineer, with the Delaware River Bridge Joint Commission Philadelphia, Pa.

HENRY R. BUCK, Consulting Engineer of Hartford, Conn., has become President of the firm, Henry Robinson Buck, Inc. HENRY WOLCOTT BUCK will be Secretary of the same organization.

GEORGE H. CONE, who has been Estimator and Engineer with W. C. Thrailkill, 812 Real Estate Building, San Antonio, Tex., is now associated with L. A. Thrailkill in the Cone Construction Company, 1023 Alamo National Building, San Antonio.

HARLAND S. PARRY, recently Resident Engineer with the Champion Fibre Company at Canton, N.C., has become Civil Engineer of the Philadelphia Department of City Transit.

MICHAEL HALPERN has been promoted from the position of Assistant Superintendent of the Port Arthur Works of the Texas Company to Assistant Manager of the Refining Department of the same organization.

J. G. ROLLINS is now a member of the firm of Womack, Henning, and Rollins, Inc., general contractors of Sherman, Tex. He was formerly Resident Engineer of the State Highway Department, with headquarters in Sherman.

J. WILSON RICHARDSON, formerly Assistant Engineer with J. E. Greiner and Company, of Baltimore, is now Maintenance Engineer for the Port of New York Authority, New York, N.Y.

EARL N. FLOYD has accepted a position as Associate Hydraulic Engineer in the U.S. Engineer Office, Louisville, Ky. Prior to that he was Assistant Superintendent of the Callahan Construction Company, Dallas, Tex.

CLIFFORD AULL BETTS has been appointed Commissioner of Streets and Sewers of Chattanooga, Tenn., but the firm of which he is a member, the Betts Engineering Company, of Chattanooga, will continue to operate.

ARTHUR D. WESTON, formerly Associate Sanitary Engineer of the Massachusetts State Department of Health, has succeeded to the post of Chief Engineer in the same department, the vacancy being caused by the resignation of X. Henry Goodnough.

MILTON L. CORNELL, President and Treasurer of the Cornell Iron Works, Inc., has been elected a trustee of Columbia University on the nomination of the graduate body.

ALBERT K. WARREN, Chief Engineer, Los Angeles County Sanitation Districts, recently visited Society Headquarters during an inspection trip of Eastern sewage disposal plants.

ROMEO R. MARTEL has been appointed Professor of Structural Engineering at the California Institute of Technology, Pasadena, after serving since 1918 as Instructor, Assistant Professor, and Associate Professor, respectively.

R. J. B. HEWSON, who has been General Manager of the Mauritius Government Railways, Port Louis, Mauritius Island, is now Chief Engineer of the Sierra Leone Railway, Clinetown, Freetown, Sierra Leone, Northwest Africa.

HUNG HSUN LING, formerly President of Nanyang University, Shanghai, has returned to China to resume his duties as Director in charge of location and construction of the Lung Hai Railway, Ministry of Railways, Nanking.

DANA E. KEPNER is manager of the Denver office of the Pacific States Cast Iron Pipe Company, 226 Continental Oil Building.

MAURICE E. GILMORE, Vice-President and General Manager of R. W. Hebard and Co., New York, has returned to San Salvador, where he is directing his company's extensive municipal-improvement operations. Mr. Gilmore has been active in organizing an engineering society in Central America.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From October 10 to November 10, 1930

ADDITIONS TO MEMBERSHIP

ACKEN, HOWARD WESNER. (Jun., Oct. '30.) 290 Livingston Ave., New Brunswick, N.J.

ANDRADE, FRANCISCO. (Assoc. M., Aug. '30.) Chief, Commercial Section, Ministry of Public Works, Apartado 1320, Bogota Colombia.

ARNOLD, RALPH RAYMOND. (M., Oct. '30.) County Surv., Contra Costa Co., Martinez, Calif.

ASHTON, FRANK WILLIAM. (Jun., Oct. '30.) 316 Eighteenth Ave., North, Clinton, Iowa.

AUER, PHILIP FENTON. (Assoc. M., Oct. '30.) Constr. Supt., Preston J. Bradshaw, Clayton, Mo.

AX, CLARENCE HERMAN. (Jun., Oct. '30.) Beta House, Washington Univ., St. Louis, Mo.

BABB, ARNOLD OBED. (Jun., Oct. '30.) Designer and Draftsman, State Road Comm., Keyser, W.Va.

BARBA, JOSEPH FRANCIS. (Jun., Oct. '30.) 1 Lee St., West Haven, Conn.

BARD, ROBERT CHARLES. (Jun., Oct. '30.) 36 South 11th Ave., Mount Vernon, N.Y.

BARKER, JOSEPH WARREN. (M., Oct. '30.) Dean, School of Eng., Columbia Univ., New York, N.Y.

BARROWS, WALTER IRVING. (M., July '30.) Power Engr., The Management Eng. & Development Co., Dayton, Ohio.

BATSON, BENJAMIN ARTHUR. (Assoc. M., Oct. '30.) Asst. Structural Engr., Dept. of Bldgs., City Hall, Cincinnati, Ohio.

BEDELL, IRA DANIEL. (Assoc. M., Oct. '30.) Asst. Engr., Bureau of Highways, Brooklyn, N.Y.

BELL, LAWRENCE WALTER. (Jun., Oct. '30.) Richards Apartments, Tuckahoe, N.Y.

BENNER, FREDERICK, JR. (Jun., Oct. '30.) Care, Carnegie Inst. of Technology, Box 226, Pittsburgh, Pa.

BERNHARDT, JOHN EDWARD. (M., May '30.) Bridge Engr., C. & E.I.Ry., 6600 South Union Ave., Chicago, Ill.

BIGELOW, HENRY WAITE, JR. (Jun., Oct. '30.) 1927 G St., N.W., Washington, D.C.

BLOSS, ERWIN ERNST. (Assoc. M., Oct. '30.) With Board of Public Service, Dept. of the Pres., St. Louis, Mo.

BODEN, WILLIAM ESTEY. (Jun., Oct. '30.) Room 1218, 225 Bush St., San Francisco, Calif.

BRETH, SAMUEL EDWARD. (Jun., Oct. '30.) 227 South College St., Martinsburg, W.Va.

BREVOORT, JAMES SCOTT. (Jun., Oct. '30.) Computer, U.S. Corps of Engrs., 1237 Fifteenth St., Rock Island, Ill.

BRINKMAN, HARRY WILLIAM. (Jun., Oct. '30.) Care, Phoenix Bridge Co., Phoenixville, Pa.

BRYANT, EDWARD KENDALL. (Assoc. M., July '30.) Asst. Engr., John L. Weber, Inc., 219 East Hanover St., Trenton, N.J.

Buckey, Charles William. (Jun., Oct. '30.) Care U.S. Geological Survey, Independence, Va.

Buell, Elmer Elliott. (Jun., June '30.) R.F.D. 5, Washington C.H., Ohio.

Byrne, John Dawson. (Jun., June '30.) With B. & M. R.R., 40 Riverdale St., Methuen, Mass.

Campbell, Harry Guy. (Assoc. M., Oct. '30.) Treas. and Managing Partner, Harry T. Campbell Sons, Co., Towson, Md.

Carden, Leo Franklin. (Jun., Oct. '30.) Shiprock, N.Mex.

Carlson, Carl Harold. (Jun., Oct. '30.) 1231 Penn Ave., Des Moines, Iowa.

Carpenter, Samuel Theodore. (Jun., Oct. '30.) Montpelier, Ohio.

Censullo, Xavier Francis. (Jun., Oct. '30.) 613 Fifteenth St., Union City, N.J.

Chinn, Michael Tungsr. (Jun., Oct. '30.) Care American Tank & Equipment Corp., Oklahoma City, Okla.

Clark, Everett Leonard. (Assoc. M., Oct. '30.) Asst. Hydr. Engr., Grade 4, Dept. of Public Works, Div. of Water Resources, Sacramento, Calif.

Clark, Owen Edward. (Assoc. M., Oct. '30.) Service Engr., Wallace & Tiernan Co., Inc., 4227 Jackman Rd., Toledo, Ohio.

Combs, Theodore Carlos. (Jun., Oct. '30.) Asst. City Engr. and Supt. of Bldg., Upland, Calif.

Cook, Warren Stewart. (Jun., Oct. '30.) Draftsman, Bridge Dept., State Highway Comm., Ames, Iowa.

Cooke, Joseph Malcolm. (Jun., Oct. '30.) Steel Detailer, Fireproof Products Co., Charleston, W.Va.

Critchfield, Clint Eugene. (Jun., Oct. '30.) Engr. and Estimator, The Carter-Waters Corp., 2440 Pennway, Kansas City, Mo.

Critchfield, Edward Marion. (Assoc. M., Oct. '30.) Designing Engr., The Carter-Waters Corporation, 2440 Pennway, Kansas City, Mo.

Cross, William Perry. (Jun., Oct. '30.) 315 Federal Bldg., Indianapolis, Ind.

Danner, Ellis. (Jun., Oct. '30.) 263 South 1st Ave., Canton, Ill.

Diehl, Edward Russell. (Assoc. M., June '30.) 57 Melwood Ave., Cherrydale, Va.

Diehl, Ray Purdy. (Jun., Oct. '30.) 575 Ellicott Sq., Buffalo, N.Y.

Diven, John M. (Assoc. M., Oct. '30.) Engr. and Salesman, The Leadite Co., Inc., 3445 Eighty-fourth St., Jackson Heights, N.Y.

Dudley, Harold Jenkins. (Assoc. M., Oct. '30.) Estimating and Contract Engr., The H. K. Ferguson Co., 1512 Baltimore Trust Bldg., Baltimore, Md.

Dunham, Orville Glover. (Jun., Oct. '30.) 1805 Water St., Olympia, Wash.

Easley, Robert Purl. (Assoc. M., Oct. '30.) R. P. Easley, Dredging and Contracting, 705 E St., Antioch, Calif.

Edwards, Ray Omer. (Assoc. M., Oct. '30.) Field Engr., Portland Cement Assoc., 47 East Yale, Orlando, Fla.

Elam, Edwin Essex. (Assoc. M., June '30.) Civ. Engr., 4330 Elba St., New Orleans, La.

Elmendorf, Vitruvius. (Assoc. M., Oct. '30.) Asst. Engr., City Engr's Office, Pasadena, Calif.

English, Claude Alfred John. (Assoc. M., June '30.) Surv., 1701 Beach St., San Francisco, Calif.

Faber, Sven Erik. (Assoc. M., Aug. '30.) Cons. Civ. Engr., Hongkong and Shanghai Bank Bldg., Shanghai, China.

Faile, Edward Hall. (M., Oct. '30.) Cons. Engr., E. H. Faile and Co., 441 Lexington Ave., New York, N.Y.

Fossnight, Rex LeRoy. (Jun., Oct. '30.) 305 Willey St., Morgantown, W.Va.

Fritz, Herbert Daniel. (Jun., Oct. '30.) City Engr., City Hall, Bettendorf, Iowa.

Fyler, Carleton Mills. (Assoc. M., June '30.) Care, Modjeski, Masters, and Chase, 610 McClure Bldg., Frankfort, Ky.

Gain, Elmer William. (Jun., Oct. '30.) Asst. Engr., St. Louis County Highway Dept., 820 Baugh Ave., East St. Louis, Ill.

Gamble, Claude Leslie. (Assoc. M., Oct. '30.) Lieut., Q.M.C., U.S.A. Office, Quartermaster General, Munitions Bldg., Washington, D.C.

Garmise, Leo. (Jun., Oct. '30.) 216 Dover St., Brooklyn, N.Y.

Gettys, Paul Eugene. (Jun., Oct. '30.) 268 Peffer St., Harrisburg, Pa.

Gilbert, Joseph Jenkins. (Jun., Oct. '30.) Draftsman, Remington, Vosbury, and Goff, 509 Cooper St., Camden, N.J.

Ginsburg, Nathan. (Jun., Oct. '30.) Designing Draftsman, New England Power Constr. Co., 89 Broad St., Boston, Mass.

Glenz, Frederick George, Jr. (Jun., Oct. '30.) 36 Little Hall, Cambridge, Mass.

Goldsmith, Abraham Michael. (Jun., June '30.) Engr., N.Y.C.R.R. and N.Y.N.H. & H.R.R., Grand Central Terminal, New York, N.Y.

Goodridge, Harry. (M., Oct. 30.) City Engr., Berkeley, Calif.

Gottlieb, Leon. (Assoc. M., Oct. '30.) Res. Engr., State Highway Dept., Birmingham, Ala.

Green, William Edward. (Jun., Oct. '30.) 956 South Ogden St., Denver, Colo.

Greene, Albert Beale. (Assoc. M., Oct. '30.) Assoc. Civ. Engr., U.S. Engr. Office, 428 Custom House, St. Louis, Mo.

Griffith, Charles Leslie. (Jun., Oct. '29.) 205 West Madison Ave., Youngstown, Ohio.

Gross, Michael Albert. (Jun., Oct. '30.) 1255 Franklin Ave., Wilkinsburg, Pa.

Grossman, Eugene. (Assoc. M., Oct. '30.) Treas., T. J. Doherty, Inc., 369 Lexington Ave., New York, N.Y.

Grytbak, Martin Sigvart. (M., Oct. '30.) Bridge Engr., City of St. Paul, St. Paul, Minn.

Hadden, Clyde Chapman. (M., Oct. '30.) Chf. Engr. of Maintenance, State Dept. of Highways, Columbus, Ohio.

Hagopian, Lemuel Theodore. (Jun., Oct. '30.) Civ. Eng. Aid., Grade II, State Dept. of Public Works, Div. of Highways, Bridge Dept., 1414 Twelfth St., Sacramento, Calif.

Hamilton, John Sowden. (Jun., Oct. '30.) 1511 Walnut St., Berkeley, Calif.

Hancock, William Gaw. (Assoc. M., Aug. '30.) Pres. and Chf. Engr., The Hancock Eng. Co., Philadelphia, Pa.

Harrold, Lloyd Larren. (Jun., Oct. '30.) 1539 Eye St., N.W., Washington, D.C.

Hart, Joseph Hall, Jr. (Jun., Oct. '30.) 3593 Alaska Ave., Cincinnati, Ohio.

Hartmann, Frederick Wesley. (Assoc. M., Oct. '30.) Asst. Mgr., Chicago Branch, National Meter Co., 1455 West Congress St., Chicago, Ill.

Hatfield, Clarence Raymond. (Assoc. M., Oct. '30.) Designer, Burns and McDonnell Eng. Co., 402 Interstate Bldg., Kansas City, Mo.

Helsel, Clarence Albert. (Jun., Oct. '30.) 829 North Euclid Ave., Pittsburgh, Pa.

Higbie, John Richard. (Jun., Oct. '30.) 904 Carteret Ave., Trenton, N.J.

Holland, Paul Leach. (Assoc. M., June '30.) Staff Engr., Mees and Mees, 202 Court Arcade, Charlotte, N.C.

Hurley, Charles Henry. (M., Oct. '30.) Field Engr., Board of Hudson River Regulating Dist., Albany, N.Y.

Hurst, Charles Walworth. (Jun., Oct. '30.) Rock Port, Mo.

Hurst, William Donald. (Jun., Oct. '30.) Care, Dept. of Civ. Eng., Virginia Polytechnic Inst., Blacksburg, Va.

Jackson, James William. (Jun., June '30.) Structural Detailer and Checker, Am. Bridge Co., Gary, Ind.

James, Norman LeRoy. (Jun., Oct. '30.) Box 237, Myrtle Point, Ore.

Jennings, Charles Harold. (Jun., Oct. '30.) Box 138, Rolla, Mo.

Johnson, Horace Allison. (Jun., Oct. '30.) Junior Civ. Eng. Draftsman, Los Angeles County, 2275 Chevy Chase Drive, Glendale, Calif.

Jovene, Nicholas Angelo. (Jun., Oct. '30.) 145 North Oxford St., Brooklyn, N.Y.

Karpov, Alexander Vladimir. (M., Oct. '30.) Designing Engr., Hydr. Dept., Aluminum Co. of America, 2426 Oliver Bldg., Pittsburgh, Pa.

Kaufholz, Ferdinand, Jr. (Jun., June '30.) Junior Civ. Engr., U.S. Public Bldgs. and Public Parks, Washington, D.C.

Kegler, Howard Lucien. (Assoc. M., Oct. '30.) Engr., Mortenson Constr. Co., 608 Indiana St., San Francisco, Calif.

Kelsey, James Robert. (Assoc. M., Oct. '30.) Chf. Asst. Engr., G. B. Woodruff, Box 534, Sound Beach, Conn.

Kerr, Clarence Marion. (Jun., Oct. '30.) Dist. Supt. of Constr., Granite Constr. Co., San José, Calif.

Kirkland, James Lee, Jr. (Jun., Oct. '30.) 1350 Belmoral Ave., Chicago, Ill.

Kish, Frank Joseph. (Jun., Oct. '30.) 701 North Luzerne Ave., Baltimore, Md.

Klorer, John. (M., Oct. '30.) Chf. Engr., Orleans Levee Board, New Orleans, La.

Kosters, Stuart Farnsworth. (Assoc. M., Jan. '29.) Care, Stone and Webster Eng. Corp., Appraisal Div., 49 Federal St., Boston, Mass.

Kunkle, Charles William. (M., Oct. '30.) Vice-Pres. and Gen. Mgr., Johnstown Water Co. and The Conemaugh & Franklin Water Co., Johnstown, Pa.

La Belle, Walter Ernest. (Jun., Oct. '30.) 745 West 54th Pl., Chicago, Ill.

Laber, Herbert John. (Jun., Oct. '30.) With R. D. Johnson, 67 Wall St., New York, N.Y.

Lacy, Roy Morris. (Jun., Oct. '30.) 5423 Geraldine Ave., St. Louis, Mo.

Larned, Arthur Thomas. (M., Oct. '30.) Engr., Elec. Bond and Share Co., 2 Rector St. New York, N.Y.

Larson, Donald Edward. (Jun., Oct. '30.) Care Chicago Bridge and Iron Works, 1305 West 105th St., Chicago, Ill.

LeFeber, Alfred. (Assoc. M., Oct. '30.) Vice-Pres., Barstow and McCurdy, Inc., Akron, Ohio.

Letherbury, John Boyd. (Jun., Oct. '30.) 710 Wingohocking St., Philadelphia, Pa.

Livesay, Durward Paul. (Jun., Oct. '30.) Bridge Draftsman, State Highway Dept., Box 372, Olympia, Wash.

Lorenzeni, Ernest Maurice. (Jun., Oct. '30.) With Am. Bitumuls Co., San Francisco, Calif.

Ludwig, Lawrence Augustus. (Jun., Oct. '30.) 360 East 23d St., Brooklyn, N.Y.

McAtee, Fay Emmitt. (Jun., Oct. '30.) Barry, Ill.

McCormick, Carroll Spear. (Assoc, M., Oct. '30.) Structural Engr., Dept. of Bldgs., City of Tacoma, Tacoma, Wash.

McDonnell, Richard Timothy. (Assoc. M., Feb. '30.) Constr. Engr., McDonnell and Gorman, Inc., 29 Consular Rd., Tientsin, China.

McLaughlin, Philip Linwood. (Assoc. M., Oct. '30.) Asst. San. Engr., Federal Water Service Corp., 27 William St., New York, N.Y.

Mahone, Leslie Wilmore. (Assoc. M., Oct. '30.) Asst. Prof., Eng. Extension Service, Iowa State Coll., Ames, Iowa.

Mangold, Robert Putnam. (Jun., Oct. '30.) 3764 West Vernon Pl., Los Angeles, Calif.

Markle, Harry Atkins, Jr. (Jun., Oct. '30.) Greenawalds, Allentown, Pa.

Marsh, Clyde Sherman. (Jun., Oct. '30.) Asst. Engr., Gulf Pipe Line Co. of Pennsylvania, 706 Victoria Bldg., St. Louis, Mo.

Messina, Richard Frank. (Jun., Oct. '30.) Concrete Foreman, W. Horace Williams Co., Eddingston Court, Apartment 0-1, Port Arthur, Tex.

Miller, Herman. (Jun., Oct. '30.) 3971 Gouverneur Ave., New York, N.Y.

Moloney, Vincent Gerard. (Assoc. M., June '30.) Eng. Draftsman, Sydney Harbur Bridge Branch, Public Works Dept., Philip St., Sydney, N.S.W., Australia.

Mundt, Keenth Francis. (Jun., Oct. '30.) 1456 Jones St., Apartment 32, San Francisco, Calif.

MUNRO, JAMES DUNCAN. (Jun., Oct. '30.) 270 West 11th St., New York, N.Y.

MURNER, HERBERT KENNETH. (Assoc. M., July '30.) 340 North Encinitas Ave., Monrovia, Calif.

MURPHY, SYLVESTER WILSON AUGUSTINE. (Jun., Oct. '30.) Designer, Frank J. Murphy, 280 West 246th St., New York, N.Y.

NEESON, JOHN HENRY. (M., Oct. '30.) Chf. Engr., Bureau of Eng. and Surveys, Philadelphia, Pa.

NEUMAN, THEODORE. (Assoc. M., Oct. '30.) Asst. Hydr. Engr., Div. of Water Resources, State Dept. of Public Works, Sacramento, Calif.

NYE, CARL MERRIMAN. (M., Oct. '30.) Asst. Chf. Engr., G.N. Ry., St. Paul, Minn.

O'CONNELL, JAMES TIMOTHY. (Jun., Oct. '30.) 302 Convent Ave., New York, N.Y.

O'NEILL, JOHN PATRICK, JR. (Jun., June '30.) Topographical Draftsman, City of Newark, 48-56 Forty-seventh St., Woodside, N.Y.

OWENS, CLAUDE PARISH. (M., June '30.) Engr. of Maintenance, State Highway Dept., Jefferson City, Mo.

PAGE, AUSTIN ELMER. (Assoc. M., July '30.) Asst. Dist. Engr., The Lane Constr. Corp., Box 217, Concord, N.H.

PETERSON, MARTIN PETER. (Assoc. M., June '30.) Constr. Engr., Vacuum Oil Co., Cairo, Egypt.

PICKLES, LOUIS WILLIAM. (Jun., Oct. '30.) 103 Madison St., Jefferson City, Mo.

PILKEY, ORRIN HENDREN. (Jun. Oct. '30.) Care, Waddell and Hardesty, 150 Broadway, New York, N.Y.

PILLSBURY, ARTHUR FRANCIS. (Jun., Oct. '30.) 1147 Keith Ave., Berkeley, Calif.

PORTER, SAMUEL DOAK. (Assoc. M., Oct. '30.) Chf. Designer, Hoar, Decker, Shoecraft, and Drury, 103 East Washington St., Ann Arbor, Mich.

PUFF, STEPHEN FRALEY. (Assoc. M., Oct. '30.) With Am. Telephone and Telegraph Co., Room 1000, 15 Dey St., New York, N.Y.

RAABERG, RALPH SKANCKE. (Assoc. M., Oct. '30.) Engr., Western Elec. Co., 80 John St., New York, N.Y.

RILEY, ELMER DARRELL. (Jun., Oct. '30.) Junior Asst., Civ. Engr., State Dept. of Public Works, 103 North Roxford St., Syracuse, N.Y.

ROCHE, EDWARD CHARLES. (Jun., Oct. '30.) Research Asst., Civ. and San. Eng., Mass. Inst. Tech., Cambridge A, Mass.

RUCKER, BOOKER HALL, JR. (Jun., Oct. '30.) City Engr., Rolla, Mo.

RYDELL, LOUIS ERNEST. (Assoc. M., Oct. '30.) Designer, Dept. of Public Utilities, City of Tacoma, Box 643, Tacoma, Wash.

SAUNDERS, WILLIAM FLEWELLYN, JR. (Assoc. M., Oct. '30.) Asst. Engr., James Black and Co., St. Louis, Mo.

SCHANTL, HANS. (M., Oct. '30.) Supt., M.-I. R.R., Bonne Terre, Mo.

SCHEER, HENRY OLIVER. (Jun., Oct. '30.) Box 368, Taylorville, Ill.

SCHMITT, WALTER FREDRICK. (Jun., Oct. '30.) 1821 Ridge Ave., Philadelphia, Pa.

SCHROEDER, FRANK WILLIAM. (Jun., Oct. '30.) 2415 Auburn Ave., Cincinnati, Ohio.

SCHULCS, JOSEPH ANDREW. (Jun., Oct. '30.) 2144 North 5th St., Philadelphia, Pa.

SCHULTZ, ERNEST RICHARD. (Jun., Oct. '30.) Room 522, Y.M.C.A., Denver, Colo.

SHERWOOD, HAROLD FLOYD. (Jun., Oct. '30.) 592 State Office Bldg., Sacramento, Calif.

SHIPP, WALTER EDWARD. (Assoc. M., June '30.) Constr. Engr., James Baird Co., Washington, D.C.

STEENBERGEN, WILLIAM ARTHUR. (Jun., Oct. '30.) Instr., Agri. Eng., and Asst. Irrig. Engr., Agri. Experiment Station, Univ. of Arizona, Tucson, Ariz.

STENGER, JOHN NICHOLAS. (Assoc. M., Oct. '30.) Engr., Water Div., Dept. of Public Utilities, Tacoma, Wash.

STOREN, HOWARD FRANCIS. (Jun., Oct. '30.) 115 Moss Ave., Detroit, Mich.

STRIEGLER, RICHMOND HOBSON. (Jun., Aug. '30.) 2211 K St., Sacramento, Calif.

TAYLOR, THOMAS GEER. (Jun., Oct. '30.) 610 East Springfield Ave., Champaign, Ill.

TWINEM, JOSEPH CONRAD. (Jun., Oct. '30.) Instr., Civ. Eng., Univ. of Maine, Orono, Me.

VANDERPOOL, GEORGE RUBEN. (Jun., Oct. '30.) Rodman, A.T. and S.F. Ry., 909 East Lincoln, Wellington, Kans.

WAGNER, RICHARD ALLEN. (Jun., Oct. '30.) General Delivery, Yreka, Calif.

WAITE, GEORGE THEODORE. (Assoc. M., Oct. '30.) Civ. Engr., California and Hawaiian Sugar Refining Corp., Ltd., Crockett, Calif.

WALFORD, RICHARD MONTAGU, JR. (Jun., Oct. '30.) 1048 Rutherford Ave., Shreveport, La.

WEBER, GUSTAVE ADOLPH. (Jun., Oct. '30.) Instrumentman, W. H. Green Corp., Westbury, N.Y.

WEGWEISER, JACOB. (Jun., Oct. '30.) 2700-A Bronx Park East, Apartment 2-A, New York, N.Y.

WHITMAN, NATHAN DAVIS, JR. (Jun., Oct. '30.) 2029 La France Ave., South Pasadena, Calif.

WHITTENBERG, GEORGE. (Assoc. M., May '30.) Div. Engr., State Highway Dept., McAlester, Okla.

WIEDENHOEFER, EDGAR PAUL. (Jun., Oct. '30.) Care Michigan Coll. of Min. and Technology, Houghton, Mich.

WILLIAMS, NORMAN FERDINAND. (Assoc. M., Oct. 30.) Engr. and Constr. Supt., Allied Engrs., Inc., Blue Ridge, Ga.

WILLIAMSON, STIRLING LEWIS. (Jun., Oct. '30.) Asst. Engr., Lee H. Williamson, Box 551, Charlottesville, Va.

WILSON, ROGER REID. (Jun., Oct. '30.) With Am. Telephone and Telegraph Co., Cleveland, Ohio.

WINTERER, FRANK HERMAN. (Assoc. M., June '30.) Structural Draftsman, Dept. of City Transit, Philadelphia, Pa.

WYMAN, ALFRED MARSHALL, JR. (Jun., Oct. '30.) 9 Ralph Ave., White Plains, N.Y.

YOUNG, MASON JAMES. (M., Oct. '30.) Maj., Corps of Engrs., U.S.A., U.S. Engr. Office, 1109 Gimbel Bldg., Philadelphia, Pa.

ZOLOTAREFF, MICHAEL MICHAEL. (Assoc. M., Oct. '30.) Eng. Draftsman, N.Y.C.R.R., Room 810, 466 Lexington Ave., New York, N.Y.

MEMBERSHIP TRANSFERS

ALTHOUSE, IRVIN HENRY. (Assoc. M., '19; M., Oct. '30.) Cons. Engr., Irrig. Equipment Eng. Co., Porterville, Calif.

BARTON, CARL OSBORN. (Jun., '22; Assoc. M., '24; M., Sept. '30.) Pres. and Gen. Mgr., The C. O. Barton Co., 1900 East Jefferson Ave., Detroit, Mich.

BROOKS, GEORGE REITZLE. (Assoc. M., '21; M., Oct. 30.) Lieut., C.E.C., U.S.N. Public Works Dept., Navy Yard, Boston, Mass.

BROWN, ROBERT FRANCIS. (Assoc. M., '25; M. Sept. '30.) Local Mgr., California Water Service Co., 336 East Market St., Stockton, Calif.

CHRISTENSEN, AAGE BROAGER. (Assoc. M., '28; M., Sept. '30.) Office and Designing Engr., Ulen Co., 23 Philhellenes St., Athens, Greece.

COPELAND, LYMAN FRANCIS. (Assoc. M., '20; M., Oct. '30.) Senior Highway Bridge Engr., Dist. 3, U.S. Bureau of Public Roads, 301 Custom House, Denver, Colo.

DAVIS, MARVIN LEE. (Assoc. M., '20; M., Sept. '30.) Civ. Engr., Firestone Tire and Rubber Co., Akron, Ohio.

DOREMUS, HAL CHELLIS. (Jun., '23; Assoc. M., Oct. '30.) Head and Prof., Dept. of Eng., John Tarleton Agri. Coll., Tarleton Station, Stephenville, Tex.

ELY, FREDERICK WARREN. (Assoc. M., '21; M., Oct. '30.) Chf. Designer, Hydr. Dept., Aluminum Co. of America, 2400 Oliver Bldg., Pittsburg, Pa.

FLETCHER, BOYNTON JONES. (Jun., '25; Assoc. M., Oct.' 30.) Designing Draftsman, Aluminum Co. of America, Wearever Bldg., New Kensington, Pa.

FOSTER, WILLIAM FLOYD. (Assoc. M., '21; M., Oct. '30.) Engr. of Sanitation, Office of County Surv., Los Angeles County, Room 700, Hall of Records, Los Angeles, Calif.

GLADDING, RAYMOND DANIEL. (Assoc. M., Dec. '20; M., Oct. '30.) Foreign Representative, Warren Brothers of Brazil, Boston, Mass.

GRIFFITH, JAMES RINALDO. (Jun., '19; Assoc. M., '23; M., Oct. '30.) Prof., Structural Eng., Oregon State Agri. Coll., Corvallis, Ore.

HAGER, OTTO ERNEST. (Assoc. M., '25; M., Sept. '30.) Asst. Engr., Bridges, N.Y.C. and St.L.R.R., 950 Terminal Tower, Cleveland, Ohio.

HASELTINE, THEODORE RAYMOND. (Jun., '26; Assoc. M., Oct. '30.) Associate Engr., Burns, McDonnell, Smith Eng. Co., Los Angeles, Calif.

HILL, GEORGE EARL. (Assoc. M., '22; M., Sept. '30.) Asst. Engr., State Highway Comm., Green Bay, Wis.

HOWE, GEORGE EDWIN. (Assoc. M., '21; M., Sept. '30.) Asst. Engr., Am. Bridge Co., 30 Church St., New York, N.Y.

HURD, HARRY LUTHER. (Assoc. M., '12; M., Oct. '30.) Asst. Engr., Board of Transportation, 103 Lafayette St., New York, N.Y.

JAMESON, WILLIAM HOWE. (Jun., '27; Assoc. M., Oct. '30.) Designer, McClintic-Marshall Co., Pittsburgh, Pa.

KARGE, FRITZ WILHELM. (Assoc. M., '21; M., Oct. '30.) Engr. of Transportation, Union Co. of California, 1123 Union Oil Bldg., Los Angeles, Calif.

KENNEDY, ROBERT CHARLES. (Assoc. M., '28; M., Sept. '30.) Chf. Designing Engr., East Bay Municipal Utility Dist., 512 Sixteenth St., Oakland, Calif.

KNABE, MARTIN CHRISTOPHER, 3D. (Jun., '29; Assoc. M., Oct. '30.) Engr. in Chg., New York Drafting Dept., McClintic-Marshall Co., 39 Broadway, New York, N.Y.

MARSH, BURTON WALLACE. (Assoc. M., '27; M., Sept. '30.) Traffic Engr., City of Philadelphia, 537 City Hall, Philadelphia, Pa.

MEYER, HARRY HELMUTH. (Jun., '21; Assoc. M., '25; M., Oct. '30.) Civ. Engr., Sanderson and Porter, 52 William St., New York, N.Y.

MILLER, ALFRED FREDERICK JENSEN. (Assoc. M., '27; M., Sept. '30.) Chf. Engr., Bldg. and Safety Div., City of Los Angeles, City Hall, Los Angeles, Calif.

MOCKLER, JOHN THOMAS. (Assoc. M., '19; M., Oct. '30.) 1st Asst. City Engr., Div. of Eng., Dept. of Public Works, Buffalo, N.Y.

MORONEY, RICHARD LEE. (Assoc. M., '26; M., Oct. '30.) Archt. and Chf. Structural Engr., Emile Weil, Inc., Whitney Bank Bldg., New Orleans, La.

NICHOLS, EARL ELMORE. (Jun., '29; Assoc. M., Aug. '30.) Engr., Standard Oil Co. of California, 621 Twenty-fifth St., Richmond, Calif.

O'CONNELL, THOMAS SARSFIELD. (Assoc. M., '27; M., Oct. '30.) Dist. Engr., State Highway Dept., Phoenix, Ariz.

QUADE, MAURICE NORTHROP. (Jun., '27; Assoc. M., Oct. '30.) Designer, Waddell and Hardesty, 150 Broadway, New York, N.Y.

SAMMELMAN, CHARLES WILLIAM SYLVERIUS. (Assoc. M., '17; M., Oct. '30.) Sec., Am. Society for Municipal Impvts., 4359 Lindell Boulevard, St. Louis, Mo.

SANDERS, MARK SEBASTIAN. (Assoc. M., '20; M., Oct. '30.) Vice-Pres. and Chf. Engr., Steel-Engrs. Co., Box 37, Salt Lake City, Utah.

SARGENT, HENRY ALFRED. (Jun., '26; Assoc. M., Oct. '30.) Office Engr., Phoenix Utility Co., Hot Springs, Ark.

SAWIN, SANFORD WALES. (Assoc. M., '19; M., Oct. '30.) Project Engr., E. I. Du Pont de Nemours & Co., Room 6010, Du Pont Bldg., Wilmington, Del.

SCANLIN, WILLIAM ROBERT. (Assoc. M., '20; M., Oct. '30.) Chf. Engr., Philadelphia Rapid Transit Co., Philadelphia, Pa.

SCHULTZ, WALTER ALBERT. (Jun., '28; Assoc. M., Oct. '30.) Asst. County Engr., Hardin County, Eldora, Iowa.

SHAMROY, NAUM LEVI. (Jun., '22; Assoc. M., Oct. '30.) Designing Draftsman, H. S. Ferguson and Co., 200 Fifth Ave., New York, N.Y.

SHAW SAUL. (Assoc. M., '27; M., Sept. '30.) Cons. Engr., Saul Shaw and Co., Federal Trust Bldg., Newark, N.J.

SPIELMAN, JOHN GODFREY. (Jun., '91; Assoc. M., '95; M., Oct. '30.) City Assessor, Long Beach, Calif.

STACKPOLE, DONALD CAMERON. (Assoc. M., '22; M., Oct. '30.) Asst. Maintenance Engr., State Highway Dept., Harrisburg, Pa.

STEWART, FRANKLIN DEAN. (Assoc. M., '27; M., May '30.) Asst. Engr., San. Eng. Div., State Dept. of Health, Columbus, Ohio.

TEMPLIN, RICHARD LAURENCE. (Jun., '16; Assoc. M., '24; M., Oct. '30.) Chf. Engr. of Tests, Aluminum Co. of America, Box 77, New Kensington, Pa.

WAGNITZ, MILTON FREDERICK. (Assoc. M., '24; M., Oct. '30.) Engr. of Public Structures, City Engr's Office, 401 City Hall, Detroit, Mich.

WANNAMAKER, WILLIAM WHETSTONE, JR. (Jun., '22; Assoc. M., Oct. '30.) Pres. and Gen. Mgr., Wannamaker and Wells, Inc., Orangeburg, S.C.

WHITTELSEY, CHARLES CHAUNCEY. (Jun., '28; Assoc. M., '30.) Engr., Ford, Bacon, and Davis, Inc., 39 Broadway, New York, N.Y.

WILLIAMS, ALAN FRANK. (Jun., '15; Assoc. M., '23; M., Oct. '30.) Div. Engr., West, Pac. R.R., Box 785, Elko, Nev.

ZANDER, GORDON. (Assoc. M., '20; M., Oct. '30.) Hydr. Engr., Div. of Water Resources, State Dept. of Public Works, 401 Public Works Bldg., Sacramento, Calif.

REINSTATEMENTS

JOHNSON, CHARLES EDWIN, Assoc. M., reinstated Nov. '30.

MCFADDEN, GAYLE, Assoc. M., reinstated Oct. '30.

MCGLATHERY, SAM LYON, Assoc. M., reinstated Nov. '30.

RESIGNATIONS

CATLETT, RICHARD HENRY, Affiliate, resigned Oct. '30.

CROM, ARTHUR SULLIVAN, Jun., resigned Oct. '30.

FELT, HALL MERLE, Jun., resigned Oct. '30.

HARDING, CHESTER, M., resigned Oct. '30.

HINMAN, HERBERT DAVIS, Assoc. M., resigned Oct. '30.

HUNTER, DON WILLIAM, Assoc. M., resigned Oct. '30.

KINGSCOTT, WALTER JOHN, Assoc. M., resigned Nov. '30.

KRACH, FRED ROY, Assoc. M., resigned Oct. '30.

WOOD, HENRY CHARLES, Jun., resigned Nov. '30.

DEATHS

BARNES, MORTIMER GRANT. Elected Assoc. M., Nov. 2, 1898; M., May 31, 1904; died Oct. 7, 1930.

BLAUVELT, LOUIS DAVID. Elected M., May 6, 1908; died Oct. 26, 1930.

CAMPEN, GEORGE LINDEN. Elected M., Oct. 5, 1909; died Sept. 21, 1930.

FULTON, WILLIAM JAMES. Elected Assoc. M., Apr. 7, 1924; died Aug. 22, 1930.

MACKAY, HENRY MARTYN. Elected M., July 10, 1907; died Oct. 25, 1930.

POLHEMUS, JAMES SUYDAM. Elected M., Oct. 3, 1894; died Sept. 29, 1930.

STOREY, FRANKLIN STEVENS. Elected Assoc. M., May 6, 1914; died Oct. 8, 1930.

THOMPSON, ARTHUR WEBSTER. Elected Assoc. M., June 4, 1902; M., Apr. 5, 1910; died Nov. 10, 1930.

TRIBUS, LOUIS LINCOLN. Elected Jun., Apr. 4, 1888; Assoc. M., June 1, 1892; M., Apr. 1, 1896; died Nov. 9, 1930.

YOUNG, SAMUEL MCCAIN. Elected Assoc. M., June 7, 1905; M., Sept. 6, 1910; died Oct. 28, 1930.

TOTAL MEMBERSHIP AS OF NOVEMBER 10, 1930

Members	5,814
Associate Members	6,136
Corporate Members	11,950
Honorary Members	17
Juniors	2,400
Affiliates	139
Fellows	7
Total	14,513

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 87 of the 1930 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; 14 years experience; just back from South America; desires responsible position, preferably on highway or railroad construction or location; also has considerable experience in general and triangulation surveys. Speaks and writes Spanish and French. Location immaterial. B-9765.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; 40 years of age; 10 years experience as railroad engineer on construction and grade crossing elimination; city and municipal engineer construction experience; and 10 years as contractor's superintendent in charge of State, county, and municipal roads, bridges, and storm sewers. C-5075.

RECENT GRADUATE CIVIL ENGINEER, 2 1/2 years of practical experience covering structural and mechanical drafting, field and office work in surveying. Salary no objective. Location anywhere in United States. C-7953.

GRADUATE CIVIL ENGINEER, Jun. Am. Soc. C.E.; age 26; married; graduate civil engineer; 3 months on water resource survey, including triangulation, traverses calculation, and plotting. One year teaching surveying, plotting, etc.; 3 1/2 years design, survey, plans, line and grade, inspection of construction. Wants inspection or construction work. C-8083.

GRADUATE CIVIL ENGINEER, experience in under-water work; one year with prominent consulting engineering firm on hydro-electric, railroad electrification, and appraisal operations; water-supply work with pitometer company; past 3 1/2 years in subway construction, doing field engineering; design of fluming, timbering, underpinning; claims, estimates. C-8090.

STRUCTURAL DESIGNING ENGINEER, Assoc. M. Am. Soc. C.E.; graduate; single; age 33; available at once. Two years mechanical experience; 7 years structural experience, consisting of steel and reinforced concrete design of superstructures and foundations for buildings; computations for location and design of highway viaducts; heavy foundation work for bridges. C-8214.

CONSTRUCTION ENGINEER, M. Am. Soc. C.E.; university graduate; 25 years general experience, irrigation, drainage, sanitation, and commercial projects, including 9 years responsible charge of construction for large oil company. Practical experience covers designs, estimates, specifications, reports, purchase of materials, and construction. Location immaterial. C-8258.

ENGINEERING EXECUTIVE, Assoc. M. Am. Soc. C.E.; age 46; married; varied experience, principally in public utilities, including engineering, construction, operation, management, purchasing, supervision of accounts, valuation cases, and legal affairs. Eastern location preferred but will go where engineering and executive experience may be combined. Available on short notice. C-8259.

EXPERIENCED DESIGNER OF HYDRO-ELECTRIC PLANTS, Assoc. M. Am. Soc. C.E.; 20 years experience in planning, design, and detail of hydro-electric plants. Established qualifications as squad leader. B-5750.

ENGINEER, Assoc. M. Am. Soc. C.E.; single; age 28; 1924 graduate; wishes to change connection. Qualified particularly for research or development work; has had considerable responsibility in erection and design of large bridges; can furnish record satisfactory to a company seeking a man for responsible position. C-6937.

BUILDING CONSTRUCTION EXECUTIVE, Jun. Am. Soc. C.E.; graduate engineer; age 31; 10 years experience building construction, New York City and suburbs; 3 years structural design, 3 years field engineering and supervision; 4 years chief estimator, construction manager for general contractor. Desires responsible position, metropolitan New York preferred, but will consider any part Eastern States. Highest references. Available. C-2194.

JUNIOR CIVIL ENGINEER; age 28; West Virginia University; over 6 years field experience, railroad, dam, highway, and miscellaneous surveys. Bulk of experience on railroad survey and construction, mainly bridge. Can take charge of party on survey or construction. Location immaterial. Salary secondary to right opportunities. C-8022.

CIVIL ENGINEER; recent graduate; single; age 26; American; 21 months experience: 14 months general and city surveying; 1 month inspection of concrete streets, sidewalks, curbs, and gutters; 6 months location of county roads and concrete bridges. Desirous of position with contractor or engineering firm. Available immediately. C-7998.

STRUCTURAL ENGINEER, Assoc. M. Am. Soc. C.E.; graduate engineer; age 31; married; 10 years experience steel and concrete, United States and abroad, for various types of structures, including industrial buildings, tall buildings and bridges. Also thorough experience on welded structures. Now employed, but desires position in charge of work in New York City. C-3480.

SANITARY OR HYDRAULIC ENGINEER, Assoc. M. Am. Soc. C.E.; age 33; married; several years experience in design of relief sewers, complete sewer systems, and sewage treatment plants. Some experience in highways, drainage, water distribution, hydro-electric plants, and electrical distribution. Immediately available. Prefers location near Great Lakes or Alaska. C-8127.

CIVIL ENGINEER, Jun. Am. Soc. C.E.; college trained; age 30; single; excellent physical condition. Eight years general construction experience; interested in heavy concrete construction; capable superintendent or assistant superintendent, inspector, or chief of party. Desires connection in or close to New York City. Salary commensurate with position. Can report on short notice. C-8257

CIVIL ENGINEER; graduate Berlin Institute of Technology; age 32; thoroughly versed designer, steel and concrete, including statical indeterminate systems. Expert on reinforced concrete. Knows how to increase efficiency of building preparation and construction. Nine years practical experience on buildings, bridges, industrial plants, waterworks. Speaks several languages. Desires responsible position, domestic or abroad. C-8217.

CIVIL ENGINEER, graduate of Delft University; married; American; 8 years experience as superintendent, expediter, estimator, and job runner, on apartment houses, mills, banks, lofts, and hotel buildings. Desires postion with general contractor. Willing to go anywhere. Speaks French German, Dutch, and a little Spanish. C-5430.

CIVIL ENGINNERING GRADUATE, Jun. Am. Soc. C.E.; graduate Midwestern university; age 27; married; Protestant; desires position with growing engineering organization as designing draftsman or field engineer. Experience of $3^1/_2$ years in bridge and building design and construction. Available immediately. Will go anywhere. Good references. C-8326.

GRADUATE CIVIL ENGINEER, Jun. Am. Soc. C.E. age 30; single. Experience: 1 year power plant design; $1^1/_2$ years designer on subway and track work; 1 year designing engineer in oil refinery; $1^1/_2$ years construction engineer and estimator with contractor on subway, sewer, and foundation work. Wants responsible position, preferably construction work. C-2541.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; Cornell graduate; age 30; practice covers 15 years general experience in mechanical and civil engineering. Design, construction of industrial buildings, office buildings, warehouses, power houses, substations, transmisson lines, engineering studies of waterworks, investigations, reports. Heavy foundations, pile and open caisson. Desires executive position with leading architects, engineers, or contractors. Good personality. B-9576.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; age 37; with 15 years experience designing, estimating, and pricing all items of general, contracts, purchasing all materials, expediting, and supervising construction of all types of buildings. Is available at once at reasonable salary as project manager, estimator, expediter or construction superintendent. B-4964.

MUNICIPAL SANITARY ENGINEER, Assoc. M. Am. Soc. C.E.; Purdue; reciprocal registration; age 41; married; 23 years varied engineering experience, sewerage, water supply, drainage, flood control, paving, land development, investigations, appraisals, court testimony, estimates, reports. Ten years in own practice. Available short notice to take charge of work anywhere. B-8557.

CONSTRUCTION ENGINEER OR SUPERINTENDENT, Assoc. M. Am. Soc. C.E., age 34; graduate; 7 years experience on construction of industrial plants throughout the country. Construction superintendent on tall commercial buildings 2 years. Speaks French and German. Available at once. C-7813.

STRUCTURAL DESIGNER, Assoc. M. Am. Soc. C.E., graduate engineer with Master's degree; experienced in foundation and superstructure design in steel and concrete for many classes of structures, but more particularly for multistoried buildings; good personality with ability to cooperate. C-3351.

CIVIL ENGINEER, Jun. Am. Soc. C.E.; Michigan graduate; age 30; Michigan registration. Qualified assistant engineer U.S. Civil Service. Two years telephone plant chief preceding college; 4 months resident engineer, sewer and water; last 3 years executive charge in construction of large program for municipal water. Desires connection with responsibility, preferably in public utility or industrial work. Will go anywhere. C-3664.

CIVIL ENGINEER, Jun. Am. Soc. C.E.; graduate Lehigh University 1926; age 26; married. Much experience in municipal work. Employed as estimator for large contracting firm and also as resident engineer. Deep foundation experience and concrete design. Now employed as chief draftsman on municipal works. Desires office employment. C-4930.

CIVIL ENGINEER, Jun. Am. Soc. C.E.; college graduate 1926; age 27; single. Experience in surveying, valuation, highway, bridge, and building construction; 2 years in South America in charge of construction of oil storage tank farm and general terminal projects. Location immaterial. C-2971.

CIVIL ENGINEER, Jun. Am. Soc. C.E.; graduate London University; age 30; married; 5 years experience field engineer in by-product coke plant and steel work construction; 2 years chief inspector in charge concrete masonry and testing laboratory on 8 miles of railway construction. Experience covers both field and office work. Location immaterial. C-7564.

STRUCTURAL ENGINEER, Assoc. M. Am. Soc. C.E.; civil engineering degree from leading Eastern university; married; 6 years broad experience with steel fabricators and engineers. Familiar with all classes of steel bridges and buildings. Desires position as structural designer, assistant engineer, or sales engineer. C-7922.

CONSTRUCTION ENGINEER, Assoc. M. Am. Soc. C.E.; age 34; married; 2 years detailed structural steel; 1 year designing bridges; 8 years general building construction; past 7 years in charge of estimating, engineering, and field supervision. C-8054.

GRADUATE ENGINEER, Jun. Am. Soc. C.E.; age 27; single; 2 years experience in sanitary engineering construction; 2 years in highway and bridge construction: 1 year with State department of conservation and development in various kinds of engineering. Will work anywhere. Prefers sanitary work. C-8173.

CIVIL ENGINEERING, Assoc. M. Am. Soc. C.E.; single; age 43; broad experience in highway and railroad location and construction; 6 years in United States, 9 years foreign, including $1^1/_2$ years A.E.F. Fluent Spanish. Health and references O.K. Employment in United States preferred, but would consider foreign location. B-5078.

EXECUTIVE ENGINEER, M. Am. Soc. C.E.; age 43. Has own business, specializing in design of industrial buildings and garages; considerable contracting experience and ability to handle all operations, from estimating to purchasing. Experience in designing all kinds of engineering structures, particularly in concrete. Desires to make connection in this country or abroad. C-2553.

GRADUATE CIVIL ENGINEER, Jun. Am. Soc. C.E.; age 27; single; American; for appointment upon notice. Now employed. Experience: 1 year railroad; 1 year United States Geological Survey; 4 years New York State highway, surveying, construction, and designing. Wishes to locate in East or South on similar work. C-8223.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 77 and 78 of the Year Book for 1930. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

COLLEGE TEXTBOOK OF GEOLOGY (pt. 2; Historical Geology). By Thomas C. Chamberlin and Rollin D. Salisbury. Rewritten and revised by Rollin T. Chamberlin and Paul MacClintock. New York, Henry Holt & Co., 1930. 906 pp., illus., col. illus., maps, 9 × 6 in., cloth. $3.75.

A revision of the well-known text, which first appeared twenty-one years ago. The revisers have largely rewritten it and have incorporated the new discoveries and new understandings which have arisen during the interval. The illustrations are of a high order of merit.

A COURSE IN ENGLISH FOR ENGINEERS (vol. 2; THE ENGINEER'S PROFESSIONAL AND BUSINESS WRITING. By Carl A. Naether and George Francis Richardson. Boston, Ginn & Co., 1930. (Engineering Series). 488 pp., 9 × 6 in., cloth. $3.00.

The second volume of this comprehensive textbook is devoted to the professional and business writing of the engineer. Every-day correspondence and sales correspondence are discussed at length, advice being given upon the composition of letters relating to orders, applications, claims, adjustments, credits, collections, and quotations.

FOUNDATIONS FOR HUMAN ENGINEERING. By Charles R. Gow. New York, Macmillan Company, 1930. 226 pp., port., 8 × 5 in., cloth. $1.60.

These discussions by the Professor of Humanics at the Massachusetts Institute of Technology present social and economic problems that confront the young engineer. They give him much sound advice upon his attitude toward his employer, his associates, and his subordinates, as well as upon his behavior in many other situations that arise in life.

A HANDBOOK OF ENGLISH IN ENGINEERING USAGE. By A. C. Howell. New York, John Wiley & Sons, 1930. 308 pp., 8 × 5 in., cloth, $2.50.

Professor Howell has compressed a great deal of definite, sensible advice within the limits of a small book. The rules of correct composition are given; grammar is reviewed briefly; punctuation is explained; and good advice is given on the composition of business letters, reports, and technical articles. The result is a very satisfactory text and reference book.

IMPURITIES IN METALS. By Colin J. Smithells. 2nd ed. New York, John Wiley & Sons, 1930. 190 pp., illus., diagrs., tables, 10 × 6 in., paper, $5.00.

Dr. Smithells gives a systematic account of our present knowledge concerning the extent to which the structure, mechanical, and electrical properties and the corrodibility of Commercial metals are affected by the inpurities and minor constituents that are always present in them. He also discusses recent developments in metallographic technic, particularly in the application of X-rays to the study of the structure of metals. The new edition is thoroughly revised and considerably expanded.

INGENIEUR-ARCHIV. Berlin, Julius Springer, 1929. 122 pp., 11 × 8 in., paper, 9,60 r.m.

A new periodical, edited by Professor R. Grammel of the Stuttgart Technical High School, which will appear at irregular intervals. The magazine will endeavor to promote intercourse between scientific research and engineering practice, especially the relations of mechanics and thermodynamics to mechanical and structural engineering. The first number contains eight papers presenting the results of recent research work upon such questions of importance as the strength of cylindrical shells under loads that are not axially symmetrical, the unsymmetrical bending of thin circular plates, and the stresses in shaft timber.

SCIENCE AND THE SCIENTIFIC MIND. By Leo E. Saidla and Warren E. Gibbs. New York, McGraw-Hill Book Co., 1930. 506 pp., 8 × 6 in., cloth, $3.00.

Contains 24 essays by such past and present scientific leaders as Tyndall, Huxley, Shaler, Pupin, Milliken and Haldane, discussing science, the scientific mind, scientific motive, science and culture, the place of science in a liberal education, science and civilization, and science and the future. While the book is intended primarily as a textbook in composition, readers who wish an insight into the metal attitude or habit of thought of the scientist will find it useful.

STRESSES DUE TO THE PRESSURE OF ONE ELASTIC Solid UPON ANOTHER. By Howard R. Thomas and Victor A. Hoersch. Urbana, University of Illinois, 1930. 56 pp., paper, $.30.

A report of an investigation conducted by the Engineering Experiment Station, University of Illinois, in cooperation with the Utilities Research Commission.

THE TORSIONAL EFFECT OF TRANSVERSE BENDING LOADS ON CHANNEL BEAMS. By Fred B. Seely, William J. Putnam, and William L. Schwalbe. Urbana, University of Illinois, 1930. 66 pp., paper. $.35.

This bulletin, published by the University of Illinois Engineering Experiment Station, is devoted to such subjects as the shear center for channel sections and the longitudinal stresses in channels when the transverse loads produce twisting with the bending.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 1,800 technical publications are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this Library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

CONCRETE ARCH, FRANCE. The Albert Louppe Reinforced-Concrete Bridge Over the Elorn Between Brest and Plougastel (Le pont en beton armé Albert Louppe sur l'Elorn, entre Brest et Plougastel), A. Coyne. *Génie Civil (Paris)*, vol. 97, no. 2512, Oct. 4, 1930, pp. 317–333, 38 figs., 10 figs. on special plate. Detailed report on design and construction of combined bridge consisting principally of three reinforced-concrete arches, of 186.4 m. span and 35.3 rise; materials handling; sinking of caissons; self-supporting formwork for arches was built on land and floated into position. Comments by designer, E. Freyssinet.

CONCRETE, DESIGN. Some Points in Reinforced-Concrete Bridge Design, C. S. Chettoe. *Soc. of Engrs.—Trans. (Lond.)*, 1929, pp. 193–209 and (discussion) 209–219, 17 figs. Problems in design of reinforced-concrete slabs, beams, rigid frame, abutments, wings, walls, and arches.

STEEL. Steel for Bridges (Aciers pour Ponts), A. Vierendeel. *Annales des Travaux Publics de Belgique (Brussels)*, vol. 83, June 1930, pp. 441–450, 2 figs. Discussion of recent European and American studies of economy of steel bridges and use of high-grade steel in bridge construction, illustrated by brief analysis of recently constructed steel-truss bridges.

STEEL-ARCH, EADS. The Eads Bridge, T. C. Shedd. *Ill. Soc. Engrs.—Annual Report*, vol. 5, no. 2, Apr. 1930, pp. 80–89, 5 figs. History of famous steel-arch bridge over Mississippi River at St. Louis; also, details of staves and assembled cord tubes, typical coupling, etc.

STEEL-ARCH, KILL VAN KULL. Closing a 1,652-Ft. Steel-Arch Bridge, 250 Ft. off Center. *Eng. News-Rec.*, vol. 105, no. 17, Oct. 23, 1930, pp. 640–645, 12 figs. Kill van Kull bridge at New York erected by cantilever method, using series of steel falsework bents; jacks in alternate bents only; closure on pin in lower chord; required stress in upper chord closing member produced by raising jacks at top of falsework bent after structure was swung as three-hinged arch; closure beyond center of arch made necessary by location of ship channel; falsework bent layout; details of falsework bent; comparative data on Sydney Harbor and Kill van Kull arches.

STEEL-ARCH, SYDNEY, AUSTRALIA. Erecting the Sydney Harbor Steel-Arch Bridge. *Eng. News-Rec.*, vol. 105, no. 17, Oct. 23, 1930, pp. 646–648, 3 figs. Report on cantilever erection and arch closure of 1,650-ft. steel-arch bridge across harbor at Sydney, Australia, without falsework, utilizing cable tiebacks; closure pins transmit all direct stresses with splice plates for secondary stresses only; anchorage details; center joint of lower chord; center joint of top chord.

STEEL-TRUSS, QUINCY, ILL. Silicon Steel Used Liberally in 1,257-Ft. Continuous-Truss Bridge, I. L. Pesses. *Eng. News-Rec.*, vol. 105, no. 15, Oct. 9, 1930, pp. 572–575, 7 figs. Report on construction of Mississippi River highway bridge at Quincy, Ill., covering two spans 627 ft. 8 in. center to center of piers; features of concrete piers; steel erection.

SUSPENSION, DESIGN. Standardization and Progress in Modern Suspension Bridges (La standardisation et les progrès des ponts suspendus modernes), G. Leinekugel le Cocq. *Societe des Ingénieurs Civils de France—Mémoires et Compte Rendu des Travaux—Bul. (Paris)*, vol. 83, nos. 5–6, May–June, 1930, pp. 475–485, 2 figs. General discussion of design practice with examples of recent suspension bridge construction in France.

SUSPENSION, DETROIT RIVER. The Ambassador Bridge, J. Jones. *Military Engr.*, vol. 22, no. 125, Sept.-Oct. 1930, pp. 401–404, 5 figs. General description of suspension bridge having main span of 1,850 ft.; roadway 47 ft. wide; heat-treated vs. cold-drawn wire; replacement of cables; characteristics of anchorages; terminals.

SUSPENSION, POUGHKEEPSIE, N. Y. Mid-Hudson Bridge Paved in Alternate Slabs to Equalize Cable Loads. *Eng. News-Rec.*, vol. 105, no. 15, Oct. 9, 1930, pp. 581–582, 2 figs. Brief report on how dead-load stresses on two suspension cables, supporting bridge at Poughkeepsie, N. Y., were equalized during laying of concrete pavement by carefully planned sequence of field operations.

SUSPENSION, TOWERS. Erection of 276-Ft. Towers for Mid-Hudson Suspension Bridge at Poughkeepsie, J. T. Martin. *Eng. News-Rec.*, vol. 105, no. 14, Oct. 2, 1930, pp. 529–531, 6 figs. Lower steel placed and traveler assembled by derrick boat; creeper traveler handles 45-ton column sections; steel fabricated for minimum of field riveting; details of erection traveler.

BUILDINGS

BANKS, AIR CONDITIONING. Gas-Fired Air Conditioning Unit in Baltimore Bank, E. D. Milener. *Heat. and Vent.*, vol. 27, no. 10, Oct. 1930, pp. 116–117, 3 figs. New cooling system can, with very slight change, be made into combination unit which will cool building in summer and heat it in winter; design and operating characteristics of gas-fired air conditioning unit; schematic diagram of silica-gel air conditioning unit.

HIGH, NEW YORK CITY. The Structural and Metal Work of the Chrysler Building, W. Van Alen. *Arch. Forum*, vol. 53, pt. 2, no. 4, Oct. 1930, pp. 493–498, 10 figs. Outline of methods of steel erection above 66th floor, with special reference to fabrication and erection of spire, 185 ft. high, 8 ft. sq. at base; use of chromium nickel steel, Nirosta, manufactured according to successful German methods; details of cast aluminum spandrels.

OFFICE, AIR CONDITIONING. Cooling Libby, McNeill, and Libby's General Offices, S. R. Lewis. *Heat. Piping and Air Conditioning*, vol. 2, no. 10, Oct. 1930, pp. 836–839, 8 figs. Problems encountered in design of heating and ventilating system in Chicago offices; constructional features; cooling in summer and humidifying in winter.

PLANTS, AIR CONDITIONING. Synthetic Weather Increases Production. *Chem. Markets*, vol. 27, no. 4, Oct. 1930, pp. 381, 383, 385, and 387, 7 figs. Air conditioning, making of artificial weather, implies automatic control, establishment, and maintenance of definite conditions of temperature, humidity, air movement, and air purity; it is applied generally for three purposes: atmospheric conditions, i.e. for drying, humidity, and for improvement of atmospheric conditions.

STEEL FRAME VS. CONCRETE. Steel Frame and Reinforced-Concrete Multi-Story Building Construction (Stahlkelett- und Eisenbeton-Hochhausbau), K. Schaechterle. *Schweizerische Bauzeitung (Zurich)*, vol. 96, no. 10, Sept. 6, 1930, pp. 115–119, 8 figs. Comparative discussion of steel frame and reinforced-concrete systems of building construction; comparative estimate of costs and weights for three-story warehouse building.

CITY AND REGIONAL PLANNING

LANDSCAPE PLOTTING. *Landscape Architecture*, Compiled Index, vol. 1–10, Oct. 1910—July 1930. Index covering the whole field of landscape planning.

CONCRETE

CONSTRUCTION. Concrete Distributed by Two Towers Connected by Adjustable Chute. *Eng. News-Rec.*, vol. 105, no. 17, Oct. 23, 1930, p. 661. Use of chute suspended from high line between two towers at opposite ends of long theater building was economic solution of concrete-distribution problem encountered recently in Beverly Hills, Calif.; hoisting tower, 247 ft. high, and 187-ft. secondary tower, without hoisting equipment, erected near front, were connected by 1-in. cable which supported 12-in. metal chute on 1:3 slope.

ELASTICITY. Elasticity of Concrete in Compression (Quelques considérations et recherches sur l'élasticité du béton à la compression), R. Dutron. *Annales des Travaux Publics de Belgique (Brussels)*, vol. 31, no. 3, June 1930, pp. 397–440, 2 special charts. Compilation of European and American data, with some results of original research, on coefficient of elasticity of concrete and its variation with composition of mix, fluidity, age, and resistance.

PROTECTIVE COATINGS. Exposed Surfaces of Concrete and Their Protection, A. B. MacMillan. *Boston Soc. Civil Engrs.—Jl.*, vol. 17, no. 8, Oct. 1930, pp. 467–473. General discussion of causes of breakdown of exposed concrete surfaces; first manifestations of disintegration; steps to delay disintegration; cost of repairing typical reinforced concrete building; specifications for patching and painting.

WINTER CONSTRUCTION. Winter Concreting Methods Applied on Contract of Moderate Size, R. C. Johnson. *Concrete*, vol. 37, no. 4, Oct. 1930, pp. 13–16, 5 figs. Report on winter construction of four-story Y.M.C.A. building in Kenosha, Wisconsin, 120 ft. by 150 ft.; wall bearing construction prolonged concreting period; frequent tests made; winter concrete plant equipment; coal and coke consumption of boiler and salamanders; cost of winter concreting.

DAMS

CONCRETE ARCH, CONSTRUCTION. Material Handling and Methods Used on the Ariel Hydro-Electric Project on the Lewis River, Wash., W. A. Scott. *Contractors and Engrs. Monthly*, vol. 21, no. 3, Sept. 1930, pp. 71–76, 6 figs. Report on construction of hydro-electric plant costing $8,500,000, including concrete arch dam about 300 ft. maximum height, 760 ft. long at crest, also concrete lines diversion tunnel 1,467 ft. long, etc.; unwatering dam site; digging below river bed; operation of slackline cableways; proportioning and mixing plant.

CONCRETE ARCH, DESIGN. Circular Concrete Arch Dam Designed by Simple Method, R. P. V. Marquardsen. *Concrete*, vol. 37, no. 4, Oct. 1930, pp. 27–29, 5 figs. Simple method for obtaining stresses in concrete dam of circular arch type, having constant cross section in any one horizontal plane; working formulas and diagrams required by designer are given. (To be continued.)

CONCRETE, CONSTRUCTION. Derricks Place 1,850 Yd. Per Day in Concreting Connecticut River Dam. *Construction Methods*, vol. 12, no. 10, Oct. 1930, pp. 36–40, 14 figs. Report on construction of 15-mile falls, lower development involving concrete dam, up to 180 ft. in height; plant consisting of four 1-yd. mixers and battery of derricks made consistently high placing record of more than 1,850 yd. per day; five cofferdams contained 37,378 cu. yd. of rock-filled cribs; 275,000 yd. of earth fill was placed.

CONCRETE, CRACKS. Cracks Observed in Dams, H. M. Westergaard. *West. Construction News*, vol. 5, no. 19, Oct. 10, 1930, pp. 495–497. Report on observations made during three-week inspection trip which took in many dams in Western United States; classification of cracks; rules for cracks and joints.

CONCRETE RESERVOIRS, GREAT BRITAIN. Reservoir at Barming, Maidstone. *Concrete and Constr. Eng. (Lond.)*, vol. 25, no. 10, Oct. 1930, pp. 543–548, 6 figs. Report on construction of reinforced-concrete water-supply reservoir having capacity of 700,000 gal.

CONSTRUCTION. Hydro Construction Costs Reduced. *Elec. World*, vol. 96, no. 13, Sept.

27, 1930, pp. 590–591, 6 figs. Construction plant minimized in erecting Waterville dam; diversion sluices useful on Osage project for Union Electric Light and Power Co.; generator repair pedestal saves in hydro construction; precast dam closes narrow channel.

Design. Comments on a Few Dams and Reservoirs, C. E. Grunsky. *Military Engr.*, vol. 22, no. 125, Sept.-Oct. 1930, pp. 395–400, 11 figs. Personal observations of number of storage dams—chiefly earth-filled and concrete dams located in California. (To be continued.)

Earth Fill, Texas. Building New Dam for Corpus Christi Water Supply. *Eng. News Rec.*, vol. 105, no. 14, Oct. 2, 1930, pp. 520–523, 7 figs. Report on construction of earth-fill dam of 61 ft., max. height, and length of 4,080 ft., including spillway 1,250 ft. long; design of Ogee overflow with crest 22 ft. below top of earth; dam rests on sand and gravel valley floor, spillway is carried on wood pile foundation.

Hydraulic Fill, Java. The First Earth Reservoir Dam of Java, Constructed by the Hydraulic-fill Method (De eerste aarden Reser voirdam op Java, gemaakt volgens de Hydraulic-Fill Werkwijze), S. H. A. Hoelzenspiesz. *Waterstaats-Ingenieur* (*Sourabaya*), vol. 18, no. 6, June 1930, pp. 161–165, 3 figs. Report on construction of moderate-size dam, dimensions of which are not given, for hydro-electric development; serious upstream slip occurred during construction.

Silting. Silting of Reservoirs, T. U. Taylor. *Univ. of Texas—Bul.*, no. 3025, July 1, 1930, 170 pp., 50 figs. Kinds of silt; silt surveys; silting of old Lake Austin; old Austin Dam and its failure; silting of new Austin Lake, Lake McMillan, Zuni Reservoir, etc.; silting in Rio Grande; silting of Colorado, Keokuk reservoir, etc.; water dams; de-silting of reservoirs and canals. Bibliography.

FLOOD CONTROL

Bank Protection. Revetments in the Vicksburg District, G. W. Vinzant. *Military Engr.*, vol. 22, no. 125, Sept.-Oct. 1930, pp. 448–453, 8 figs. Review of early and modern methods of construction; procuring willows; willow mats; plant layout for sinking concrete mats; connecting subaqueous mat and upper bank work; mixing and casting plants.

Levees, Construction. Force-Account Levee Construction, W. F. Lineberger. *Eng. News-Rec.*, vol. 105, no. 14, Oct. 1930, p. 542. Discussion of article previously indexed from issue of Sept. 18, 1930.

Mississippi River. The Defense Against Old Man River, R. K. Tomlin. *Construction Methods*, vol. 12, no. 10, Oct. 1930, pp. 58–61, 14 figs. Construction of framed type of willow mattress revetment. (Continuation of serial.)

FLOW OF FLUIDS

Design of Pipe Lines. Calculation of Pipe Lines for Viscous Fluids (Berechnung von Rohrleitungen fuer Zaehe Fluessigkeiten), W. Gutermann and H. Kroessin. *Waerme* (*Berlin*), vol. 53, no. 38, Sept. 20, 1930, pp. 704–706, 6 figs. Simple values are given for relation between friction coefficient and Reynolds coefficient in dependence upon nature of flow; influence of temperature on viscosity and, therefore, on Reynolds coefficient and flow conditions; by applying this calculation to flow of tar, limit values are obtained for temperature, diameter, and speed as basis for economic design of pipe lines.

FOUNDATIONS

Durability of Sheet Piling. Life of Larssen Sheet Piling Seawall in Tropical Sea Water (Ueber die Lebensdauer einer Uferwand aus Spundwandeisen Larssen in tropischem Meerwasser), G. Peter. *Bauingenieur* (*Berlin*), vol. 11, no. 33, Aug. 15, 1930, pp. 572–573, 2 figs. Report on inspection of steel sheet piling seawall, 800 m. long, on Island of St. Thomas, in West Indies, 17 years after its construction; author estimates total probable life of structure at 60 to 100 years.

Underpinning. Complete Underpinning of a 14-Story San Francisco Office Building, V. W. Rosendahl. *West. Construction News*, vol. 5, no. 19, Oct. 10, 1930, pp. 481–486, 8 figs. Report on replacement of wood pile foundation with caissons and structural steel; plant layout and excavation diagram.

Underpinning the Corner of a Building with Reinforced Concrete (Abfangung einer Gebaeudecke in Eisenbeton), Thomas. *Zement* (*Charlottenburg*), vol. 19, no. 26, June 26, 1930, pp. 616–617, 3 figs. Method used in underpinning corner of building, walls at corner having been cut away up to first floor level; erection of column was avoided by use of cantilever construction in reinforced concrete.

HYDRO-ELECTRIC POWER PLANTS

Scotland. The Lochaber Water-Power Scheme. *Water and Water Eng.* (*Lond*), vol. 32, no. 382, Oct. 20, 1930, pp. 481–486, 5 figs. Progress report on construction of concrete-lined tunnel, 16 ft. in diam. and 15 mi. long, through mountain range composed mainly of granites and schists; details of final blasting for opening tunnel into Loch Treig.

INLAND WATERWAYS

France. Transformation of the Ourcq Canal Into a Wide Section Navigable Waterway and the Establishment of a Port at Pantin, Seine. [La transformation du canal de l'Ourcq en voie navigable à grande section et la création d'un port à Pantin (Seine)], L. Subquet. *Génie Civil* (*Paris*), vol. 97, no. 15, Oct. 11, 1930, pp. 353–359, 20 figs. Report on widening of old canal to width of 28 to 50 m., at water level, to make it navigable to craft of 1,000 tons and draft of 3.2 m.; features of concrete retaining walls, canal port structures, warehouses, alcohol tanks, etc.

Utilization of River Rhone from Point of View of Navigation, Irrigation, and Hydro-electric Developments (L'Aménagement du Rhone au triple point de vue des forces hydrauliques, de la navigation, et des irrigations), R. Tavernier. *Les Annales de L'Energie* (*Grenoble*), vol. 13, no. 2, Aug. 1930, pp. 27–35. Continuation of article in Sept. and Nov. 1929 issues of same journal (see Engineering Index 1929, p. 1586); notes on work of Bureau of Transportation and Chambers of Commerce; tabulation of power obtainable in France; planning of canal lateral with Rhone; utilization of river.

Germany. Construction of Plauer and Ihle Canals as Part of Mitteland Canal (Ausbau des Plauer und des Ihle-Kanals als Teil des Mittelland-kanals), Ostmann. *Zeit. fuer Bauwesen* (*Berlin*), vol. 80, no. 9, Sept. 1930, pp. 225–238, 13 figs. Development of Plauer Canal from Elbe to Havel, since Seventeenth Century, and of Ihle Canal since 1865; re-design of two canals making them navigable to craft drawing 1.6 m.; features of locks, steel, and concrete bridges, etc.

Transportation, Netherlands. Damming and Draining of Zuider Zee and Inland Navigation (De afsluiting en droogmaking van der Zuiderzee en de Binnenscheepvaart), C. Biemond. *Ingenieur* (*Hague*), vol. 45, no. 28, July 11, 1930, pp. T63-T68 and (discussion) T.68–T.70 6 figs. Statistical data on navigation in Zuider Zee; suggestion of measures for minimizing unfavorable effects of draining of Zuider Zee on water transportation in districts affected.

Welland Canal. Completion of Canada's Greatest Engineering Enterprise, the Welland Ship Canal. *Contract Rec.* (*Toronto*), vol. 44, no. 42, Oct. 15, 1930, 29 pp. between pp. 1285–1330, 37 figs. Symposium on new $120,000,000 waterway over Niagara escarpment to connect Lake Erie and Lake Ontario and provide passage for largest lake ships; design of canal; description of seven lift locks and one guard lock; details of lock gates and lock operation; Chippewa Creek syphon; features of mitering gates weighing as much as 500 tons per leaf; timber unwatering gates; bridges over canal; how Welland Canal is lighted.

IRRIGATION

Boulder Dam Project. Controlling the Colorado, R. F. Walter. *Eng. News-Rec.*, vol. 104, no. 6, Feb. 6, 1930, pp. 247–253, 9 figs. Chief engineer of U.S. Bureau of Reclamation discusses Boulder Canyon project; discharge of Colorado River; flood control; irrigation and power storage; silt storage; dimensions of dam; plans for building involve earth-fill cofferdams and four diversion tunnels; outlet works; railroad from Las Vegas, Nev., will be first item of construction; total expenditure of $165,000,000 is provided for in Boulder Canyon Act.

Drainage, Pumping. Deep Wells and Pumps for Drainage and Supplemental Irrigation, E. H. Neal. *Agric. Eng.*, vol. 11, no. 10, Oct. 1930, pp. 333–334, 2 figs. Report on pumping from underground for effecting drainage and on making pumped water available for irrigation use, demonstrated by experience on California, Arizona, etc.; installation of deep well pumps studied by Department of Agricultural Engineering of University of Idaho.

MATERIALS TESTING

Cast Iron. The Effect of Melting Conditions on the Micro-structure and Mechanical Strengths of Grey Cast Irons Containing Various Amounts of Carbon and Silicon, A. L. Norbury and E. Morgan. *Iron and Steel Inst.—Jl.*, vol. 121, no. 1, 1930, pp. 367–386 and (discussion) 387–415, 32 figs. partly on supp. Paper previously indexed from Advance Paper, May 1930.

Hardness. Practical Experiences in Hardness Testing, B. Brown. *Am. Mach.*, vol. 73, no. 17, Oct. 23, 1930, pp. 651–654, 4 figs. Observations concerning utility of various machines for measuring hardness, especially of sheet stock, in English metal-working shops.

Properties of Aluminum Alloys. Modulus of Elasticity of Aluminum Alloys, R. I. Templin and D. A. Paul. *Am. Inst. Min. and Met. Engrs.—Tech. Pub.*, no. 366, Sept. 1930, 9 pp., 5 figs. Modulus of elasticity of aluminum as affected by alloying elements commonly used; results of tensile tests made on aluminum-magnesium series of alloys, both heat-treated and not heat-treated, on number of alloys of aluminum-magnesium type containing different percentages of various alloying elements, and on number of aluminum alloys containing appreciable amounts of alloying elements; apparatus used; method of determining E from tensile stress-strain data.

Steel, Temperature Effect. Permanence of Dimensions Under Stress at Elevated Temperatures, W. H. Hatfield. *Engineer* (*Lond.*), vol. 150, no. 3900, Oct. 10, 1930, pp. 408–410, 1 fig. Statement of author's views and experimental evidence which can be judged upon its own merits; for practical purposes, permanence of dimensions within certain range of stress is obtained; permissible stress; initial movement of consequence in excess of elastic deformation does not really take place within what may be termed practical elastic range of material. Paper read before Iron and Steel Inst.

Strength. Factors of Safety. *Elecn.* (*Lond.*), vol. 105, no. 2732, Oct. 10, 1930, p. 437. Uncertainty as to nature and magnitude of stresses; importance of ductility; fatigue strength.

Welds. Magnetographic Inspection of Welds T. R. Watts. *Welding Engr.*, vol. 15, no. 10, Oct. 1930, pp. 31–35, 8 figs. Improved methods and apparatus for making and recording magnetographs by passing magnetic flux through weld (lines of flux perpendicular to welded seam), and obtaining picture of leakage flux over weld by means of iron filings; magnetographs of good welds and poor ones having various specified faults are shown for comparison, together with tensile-test data.

Testing Welded Construction During Production. *Chem. and Met. Eng.*, vol. 37, no. 10, Oct. 1930, pp. 609–610, 7 figs. Description of control procedure developed at Barberton (Ohio) works of Babcock and Wilcox Co.; St. John X-ray machine set up for routine factory inspection of welded seams in pressure vessels, heat exchangers, and similar equipment; 18-in. section of weld is photographed at each exposure as X-ray apparatus is moved along longitudinal seam.

Testing Welds, G. B. Moynahan. *Metallurgist* (*Supp. to Engineer, Lond.*), Sept. 1930, pp. 143–144. Review of paper previously indexed from Metals and Alloys, July, 1930.

PORTS AND MARITIME STRUCTURES

Concrete Seawalls. New Seawall at Bridlington. *Concrete and Constr. Eng.*, (*Lond.*), vol. 25, no. 10, Oct. 1930, pp. 549–554, 7 figs. Report on construction of mass-concrete seawalls, 1,500 ft. long, faced with pre-cast concrete blocks, and of other structures for prevention of coast erosion.

Construction of Seawalls. Alki Avenue Seawall, Seattle, Washington, D. A. Boyle. *West Construction News*, vol. 5, no. 19, Oct. 10, 1930, pp. 487–488, 2 figs. Report of construction of seawall 5,400 ft. long, consisting of Larssen steel sheet piling carrying reinforced concrete coping; cost of wall is $78,509.

Lynn, Mass. Lynn Harbor Improvements Include Sewage Disposal, M. G. Mansfield. *Eng. News-Rec.*, vol. 105, no. 15, Oct. 9, 1930, pp. 568–571, 5 figs. Outline of project for elimination of sewage from harbor, involving construction of new 60-in. cast-iron pipe outfall sewer, automatically controlled electric-driven pumps, bulkhead, dredging and filling flats, and deepening ship channel.

Marseilles, France. The Port of Marseilles (Der Hafen von Marseille), A. Bolle. *Zentralblatt der Bauverwaltung* (*Berlin*), vol. 50, nos. 36 and 37, Sept. 10, 1930, pp. 639–643, and Sept. 17, pp. 650–654, 18 figs. Plan and description of port and its proposed extension; details of cellular concrete construction of breakwaters, quaywalls, and other marine structures; features of terminal warehouses, cranes, and other cargo-handling equipment, with special reference to petroleum unloading facilities; administration and operation of port; statistical data on port commerce.

Oakland, Calif. Oakland Looks to The Sea, G. B. Hegardt. *Pac. Mar. Rev.*, vol. 27, no. 10, Oct. 1930, pp. 428–432, 13 figs., 1 supp. map. California's latest major port, linking air, rail, and waterways; strategic location; harbor and channel improvements; port facilities; municipal piers; municipal airport; industrial areas. See also Engineering Index 1929, p. 1435.

Stockholm. The Port of Stockholm. *Dock and Harbour Authority* (*Lond*)., vol. 10, no. 120, Oct. 1930, pp. 374–380, 16 figs. Regular shipping lines from port; harbor traffic; revenue; bunkers and fresh water; airport; fire appliances in port; development in recent decades of port and its shipping. (Concluded.)

Terminals, New York. New York Union Inland Freight Terminals, H. S. Cullman. *World*

Ports, vol. 18, no. 12, Oct. 1930, pp. 1119–1124. First universal inland station about to be built, what it is, how it will function, and in what respect it will relieve freight and traffic situation in port district; proposed freight terminal will front on Eighth and on Ninth Avenues, both of which are 100-ft. streets; sides of building will be on West 15th and West 16th streets, both of which are 60 ft. wide, one and one-half blocks from group of piers serving transatlantic lines and located in largest package freight center of port.

ROADS AND STREETS

ASPHALTIC CONCRETE PAVEMENTS. Some Features of the Construction of the Leif Eriksen Drive from Oakwood Boulevard Drive to 51st Street, Lake Front Extension, Chicago, W. M. Flood. *Ill. Soc. of Engrs.—Annual Report*, vol. 5, no. 2, Apr. 1930, pp. 173–180, 6 figs. Construction report, with special reference to laying of 10-in. macadam base, asphaltic concrete paving mixture, etc.; cold weather conditions to be contended with; total yardage completed measured 67,103 sq. yd.

ASPHALT, CONSTRUCTION. Trend of Practice in Asphalt Paving, E. H. Scott. *Can. Engr.* (*Toronto*), vol. 59, no. 13, Sept. 23, 1930, pp. 257–258D and 258J, 6 figs. Construction and maintenance of sheet asphalt, mixed macadam, penetration and retread pavements; temperature stresses; resurfacing old roads; maintenance of secondary roads; types compared; asphaltic mixed macadam; reasons for methods used; rolling hot, mixtures; surface-treated, mixed macadam; asphalt plant inspectors and road inspector's duties; sheet asphalt and asphaltic concrete; correcting hair checking.

CONCRETE. Trend of Practice in Concrete Paving, E. M. Fleming. *Can. Engr.* (*Toronto*), vol. 59, no. 13, Sept. 23, 1930, pp. 252–256, 5 figs. Tandem mixing increases yardage laid; traffic lanes 10 ft. wide now standard; new machinery; pavement thickness; joints; reinforcement; grading; measurement of materials; mixing; finishing; curing; testing.

CONCRETE, JOINTS. Concrete Roads and Their Joints, H. C. Johnson. *Engineer* (*Lond.*), vol. 150, no. 3898, Sept. 26, 1930, p. 349, 3 figs. Particulars concerning mile of concrete road which author built ten years ago in Cork, Ireland, which has had no repairs in meanwhile and still exhibits no defects; transverse steel reinforcement in roadway is laid with slight dip in center so that it is $2^1/_2$ in. from under surface in middle and 2 in. from upper surface at sides; when such road is laid at average temperature, no allowance for expansion is necessary, concrete being able, by elastic compression, to take up any expansion which may occur in warmer weather.

CONSTRUCTION, CALIFORNIA. Widening a Mountain Road with Penetration Macadam Pavement, S. V. Cortelyou. *Roads and Streets*, vol. 70, no. 10, Oct. 1930, pp. 341–344, 8 figs. Emulsified asphalt used as binder in paving crescent-shaped areas adjoining original surface, on curves of Ridge Road, across Coast Range, in Southern California.

DESIGN. Road Design for Uniform Speed, W. R. Young. *Eng. News-Rec.*, vol. 105, no. 14, Oct. 2, 1930, p. 539, 3 figs. Curve super-elevation and other design features predicted on adopted uniform theoretical speed; charts showing maximum degree of curve; sight distance and difference in grades on summits; relation between speed, super-elevation, and degree of curvature.

Road Location and Design for Snow Drift Prevention, W. Schultz. *Pub. Works*, vol. 61, no. 10, Oct. 1930, pp. 25–26, 70, 72, and 74, 7 figs. Author recommends location in valleys and on windward side of slopes; raising roadbed above surrounding country; wide and shallow cuts; snow fence easement.

EUROPE. Concrete and Cement-Macadam Roads in Europe. *Eng. News-Rec.*, vol. 105, no. 17, Oct. 23, 1930, pp. 650–652, 4 figs. Excerpts from reports on foreign practice to International Road Congress reveal trend from special concretes to standard mixtures; prevalence of steel-tired traffic keeps two-course construction in favor; cement-bound macadam is being rapidly developed for light traffic.

MATERIALS, EMULSIONS. Trend of Practice in Emulsions, R. Arnold. *Can. Engr.* (*Toronto*), vol. 59, no. 13, Sept. 23, 1930, pp. 258G–258H and 258J, 5 figs. Experience of Contra Costa County, California; cold-laid asphalt surface built on old gravel at cost of only \$2500 to \$3500 per mi.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE, MINEOLA, N.Y. Activated Sludge Plant Runs Itself at Night, C. Potts. *Am. City*, vol. 43, no. 4, Oct. 1930, pp. 102–104, 3 figs. Features of sewage disposal plant of Mineola, Long Island, designed to treat flow of 1,000,000 gal. per day; percolation beds, aeration tanks, preliminary settling tanks, sludge digestion tanks, blower house, etc.; operation.

BUENOS AIRES. Construction of New Sewer System for the City of Buenos Aires (Bau der neuen abwaesseranlage der stadt Buenos Aires), K. Laucher. *Bauingenieur* (*Berlin*), vol. 11, no. 28, July 11, 1930, pp. 488–493, 13 figs. Design and construction of new sewer main, including cast-iron pipe line, 3 m. in diameter, 13,760 m. long, also reinforced-concrete tunnel section, about 1,300 m. long, of which 916 m. were built under water, precast reinforced-concrete section 15 m. long; methods of launching and towing of concrete sections.

CAIRO, EGYPT. Cairo Main Drainage Extensions, A. O. W. D. Pinson. *Surveyor* (*Lond.*), vol. 78, no. 2020, Oct. 10, 1930, p. 344. Abstract of paper to be brought forward for discussion at Institution of Civil Engineers; early working of drainage system; new extension works: 45-in. diam. rising main, collector, and main sewers; ventilation of collector; corrosion of concrete in collector; unforeseen loading of system; cost was 310,000 Egyptian pounds.

CALIFORNIA. Sewerage Improvements at Salinas, California, M. L. Crist. *West Construction News*, vol. 5, no. 18, Sept. 25, 1930, pp. 459–461, 6 figs. Description of new sewerage system including storm sewer 25,000 ft. long, consisting of 12- to 36-in. centrifugally spun Hume concrete pipe; disposal of trade wastes; layout of treatment plant with floating concrete roof on sludge-digestion tank; gas dome and sludge samplers; costs.

DISPOSAL PRACTICE. The Present Trend in Sewerage and Sewage Disposal Practice, W. W. Horner. *Engrs.' Club of St. Louis—Jl.*, vol. 10, no. 9, Sept. 1930, 12 pp. Historical review of sewer systems; city planning definite aid in design of systems; construction materials.

PLANT, OREGON. Treatment Plant and Intercepting Sewers for Klamath Falls, Oregon, C. C. Kennedy. *West. Construction News*, vol. 5, no. 18, Sept. 25, 1930, pp. 448–452, 7 figs. Description of sewage disposal serving city of over 16,000 in population, consisting of primary sedimentation tank with provision for continuous sludge removal and skimming, separate sludge digestion, with gas collection and heating of digesting sludge, and chlorination of effluent; operation data.

PLANTS, OPERATION. Operation of Sewage Disposal Plants of the Tank and Filter Type, V. W. Whitfield. *Am. City*, vol. 43, no. 4, Oct. 1930, pp. 96–100 8 figs. Care of Imhoff tank; miscellaneous implements for operation of sewage treatment plants; trickling filters; sand filters; suggested schedule of routine operations; methylene blue test for stability of effluent; test for settleable solids, etc.; suggested laboratory equipment.

PLANTS, PEORIA, ILL. Sewage Treatment Works Designed for the Caterpillar Tractor Co., Peoria, Ill., H. W. Harmon, J. A. Harmon. *Ill. Soc. Engrs.—Annual Report*, vol. 5, no. 2, Apr. 1930, pp. 110–117, 1 fig. Description of treatment plant designed for factory population of 8,000; sanitary analysis of sewage samples; activated sludge process chosen; estimated cost of entire plant is \$60,000.

PUMPING STATIONS, LYNN, MASS. Automatically Controlled Electric-Driven Pumps Keep Sewage Out of Lynn Harbor, M. G. Mansfield. *Eng. News-Rec.*, vol. 105, no. 16, Oct. 16, 1930, pp. 605–609, 8 figs. Variations in sewage flow and tide level met in pumping plant of 90,000,000 gal. daily capacity by throwing pumps in or out by float switches and by motor-speed control regulators; construction of pumping station; pumping equipment consists of four motor-driven vertical centrifugal units; two having capacity of 15 m.g.d. and two capacity of 30 m.g.d.; operation; pumping station and equipment cost \$454,000.

TUNNELS

CONSTRUCTION OF GAS PIPE LINES. Gas Engineers Tunnel Tracks by Novel Means. *Gas Age-Rec.*, vol. 66, no. 6, Aug. 1930, p. 208, 1 fig. Method used by Public Service Corp. of N.J. to lay 24-in. gas main under Erie main line tracks at Rutherford, N.J.; test holes showed 5 ft. of quicksand on shale; well points sunk 18 ft. deep, 3 ft. apart on both sides of roadbed; water level pumped to below proposed work; bolted-segment rings, $57\ ^1/_4$ in. outside diameter, assembled in shaft and jacked forward; after installation of pipe, tunnel refilled with excavated material by water jet method.

WATER SUPPLY, CONCRETE LINING. Full-circle Section of 17-Ft. Tunnel Lined in Single Pour. *Eng. News-Rec.*, vol. 105, no. 16, Oct. 16 1930, pp. 610–612, 2 figs. Circular steel forms 40 ft. long on 83-ft. carriage simplify and speed up lining of 13,000-ft. Cushman tunnel near Tacoma, Wash.; all concrete is put into form by means of 2-cu. yd. pneumatic concrete gun with 6-in. delivery pipe about 80 ft. long; concrete crew can work 8 hours out of each 24, placing 140 cu. yd. required for each set-up of form.

WATER PIPE LINES

SUBAQUEOUS. Problems Met in Re-laying an Old Submarine Pipe Line, H. U. Fuller. *Water Works Eng.*, vol. 83, no. 22, Oct. 22, 1930, pp. 1581–1582, and 1626, 4 figs. Report on raising and relaying of old leaky pipe line in Casco Bay, Portland, Maine; laying 12-in. main, 1,700 ft. long, between mainland and Mackworths Island and 8-in. main, 6,800 ft. long, between Mackworths Island and Great Diamond Island; method of dredging; costs. Excerpts from paper read before New Eng. Water Works Assn.

WATER PUMPING PLANTS

AUTOMATIC. Automatic Control in Water Work Pumping Stations L Small. *Water Works Eng.*, vol. 83, no. 22, Oct. 22, 1930, pp. 1585–1586, 1600, 1603, and 1604, 4 figs. Discussion of advantage of building such stations underground, types of motors, control systems, etc., in light of experience of Baltimore Water Works; altitude valve control method; trouble with station valves; pump discharge valves; brief description of Catonsville automatic pumping station of Baltimore; electric metering and control panels; motor starters of carbon pile resister type. Excerpts from paper read before Maryland-Delaware Water and Sewerage Association.

WATER TREATMENT

AERATION. Aeration at the New Waukegan, Ill., Filtration and Pumping Plant, H. Vagtborg. *Am. City*, vol. 43, no. 4, Oct. 1930, pp. 111–113, 3 figs. Notes on special form of aerator, devised by H. A. Allen, and other novel features.

BACTERIOLOGY. Bacterial Aftergrowth in Water Distribution System, J. R. Baylis. *Water Works and Sewerage*, vol. 77, no. 10, Oct. 1930, pp. 335–338. Study of bacterial increases in water after it leaves purification works; experiences at Baltimore, Md.; growth of B.Coli on decaying micro-organisms; determination of growth on sediment; bacterial growth in pipe sediment; how to avoid bacterial aftergrowths.

FILTRATION, MICRO-ORGANISMS. How Does Microscopic Plant Life Affect Filter Runs, L. A. Marshall. *Water Works Eng.*, vol. 83, no. 20, Sept. 24, 1930, pp. 1443–1444 and 1482, 2 figs. Report based on experience with filtration plants at Cleveland, Ohio; method of counting micro-organisms; treatment of filtered water; relation of average period of service to average number of micro-organisms in water applied to filters; reduction in number affected by coagulation; ample wash water supply is directly related to length of filter runs.

FILTRATION PLANTS, TESTING. Necessary Tests at Small Filtration Plants, J. M. Jester. *Water Works and Sewerage*, vol. 77, no. 10, Oct. 1930, pp. 364–365. Set of simple tests that can be run by smallest plant and inexperienced operator; sampling; turbidity; hydrogen-ion concentration; hardness; residual chlorine; taste and odors.

LONDON. Progress in Water Purification, A. Houston. *Contract Rec.* (*Toronto*), vol. 44, no. 42, Oct. 15, 1930, pp. 1278–1280. Review of 24th annual report on London water supply; taste removal; pre-filtration waters; value of primary filters; Wilson and Blair's medium; iodine in water; activated carbon for taste removal.

TREATMENT. Removal of Lead, Zinc, Copper, and Tin from Drinking Water by Means of Base-Exchange Materials, B. A. Adams. *Water and Water Eng.* (*Lond.*), vol. 32, no. 381, Sept. 20, 1930, pp. 415–419. Report on experiments made at Teddington Chemical Research Laboratories; copper salts in presence of citric acid or citrates may be removed by treatment with manganese permutite; regeneration of zeolite. Bibliography.

WATER WORKS ENGINEERING

INTAKES. Anchor Ice Intake Troubles, How They May Be Remedied, C. H. Lord. *Water Works Eng.*, vol. 83, no. 22, Oct. 22, 1930, pp. 1583–1585 and 1620, 2 figs. Engineer, Board of Public Control, Ogdensburg, N.Y., reports on ice trouble at St. Lawrence intake pumping station; use of wooden pad drives out anchor ice; freezing over relieves situation; revolving screens sometimes provide anchor ice remedy. Excerpts from paper read before Am. Water Works Assn.

OSAKA, JAPAN. Municipal Water Works of Osaka, E. Kusano. *Far East. Rev.* (*Shanghai*), vol. 26, no. 8, Aug. 1930, pp. 415–420, 7 figs. History of water works in Japan; enactment of water-works act; main features of 8,000,000 yen water-works extension enabling system to serve total population of 2,750,000; extensions include additional intake tower and grit chambers; four additional intake pumps pumping water to height of 12.2 m.

WATER PROBLEMS. Superintendents' Round Table Discussion. *Am. Water Works Assn.—Jl.*, vol. 22, no. 10, Oct. 1930, pp. 1303–1344. Part of proceedings of St. Louis Convention of American Water Works Association, June 2, 1930; installation and care of centrifugal pumps; clearance between water mains and sub-surface structures; inspection of fire hydrants and division of responsibility between fire and water departments; water mains on bridges and air relief valves in cold climates; painting and maintenance of elevated tanks and standpipes; assessments for water mains against frontage.